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Ecological responses of macroinvertebrates to human-impacts of a rural-urban flowing river in delta state, Nigeria

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Abstract

Anwai River is one of the essential water resources situated in Asaba, the Delta State capital in Nigeria. The Delta State Government channelled the river to combat the menace of flood in the State capital. Before channelization, the river has been under intense human-stressors in and around the river. Data collected from three (3) sampling stations with varied human impact for six months in 2019; aimed to evaluate the structure and ecological responses of macroinvertebrates to habitat disturbances and anthropic activities in the river. Low levels of; nitrate (≤10mg/L), pH (acidic) and dissolved oxygen values recorded in this study pinpoint the deteriorating quality of Anwai River following the influx of organic pollutants due to habitat alteration. Macroinvertebrate community abundance generally inferior in Anwai River; with the dominance of organic pollution tolerant groups include Dipteran, Odonatan and Hemipteran. The study noted a difference in the Macroinvertebrate abundance and distribution was significantly different in the channelized and non-channelized portions of Anwai River. Macroinvertebrates population more in the unregulated section of the River. Measured biological indices reflected values ≤1.0 in all study stations, reconfirmed Anwai River organically polluted as a result of anthropogenic activity in its watershed. The long records of chironomids in this study area revealed the River a threat not just to the life forms in the water body but also to humans utilizing this river for various functions. The River's present status requires urgent sustainable water remediation plan to sustain and improve its water quality.

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Introduction

The perturbation of rivers through increased precipitation, storm water and flooding activity is of global concern. These natural stressors pressure the river's biota both directly and indirectly fashioning a stable or unstable ecosystem community, population and productivity (White *et al.*, 2018, Iloba and Akpoyibo, 2019). The resultant environmental variabilities, due to these pressures abstraction, in structuring river communities have received much interest, particularly concerning the freshwater ecosystem (Nieto *et al.*, 2017; Khudhair *et al.*, 2019). In other to combat this menace, rivers are channelized; restricting flow to the main channel and disconnecting it from the surrounding riparian zone (Smith *et al.*, 2019).

River channels in many areas of the world have been straightened, deepened, widened, and leveed for numerous reasons depending on the threat concomitant with such environments (Kennedy and Turner, 2011; Akinremi *et al.*, 2016). The changes in the riverbed and riverbank alter the hydrologic regimes and fluvial processes of the river in sophisticated manners. These manifested at a range of spatial and temporal scales and to landscape-level patterns and processes (USEPA, 2011; White *et al.*, 2018). The aftermath effects of channelling the River caused retention capabilities. These include increased flow velocity, and loss of habitat patchiness can have a massive impact on macroinvertebrate abundance, richness and diversity (USEPA, 2011; Kamgan *et al.*, 2017). In addition to habitat aberration, the channelling of river disrupts the highly diversified biotas in rivers and associated riparian areas (Kennedy and Turner, 2011).

Macroinvertebrates are of multiple benefits to the aquatic ecosystems; rich in nutrient, involved in carbon recycling and water purification as well as improves soil fertility (Li *et al.*, 2015; Nieto *et al.*, 2017; Dalu and Chauke, 2020). In addition to the aforementioned, macroinvertebrates are primary exploiters of organic materials and the end products transferred to other trophic levels through the food web (Li *et al.*, 2015; Madomguia *et al.*, 2016). It is crucial to understand the responses of macroinvertebrates to environmental changes in Channelled Rivers. Other human habitat disturbances postulate choke of the microbiota is of urgent importance to reduce significant extinction threats (USEPA, 2011; Kennedy and Turner, 2011).

The Anwai River is a small lowland stream that serves as a primary source of water supply for domestic and agricultural processes, to inhabitants of the surrounding communities. The river has been under different types of human stressors. Recently, the Delta State Government Channelled Anwai River into solving the capital city flood menace. The potentially harmful sanitary practices by human communities along the shores of this river must have impacted on the river’s sediment or bottom, substratum, the home of macroinvertebrates (Kumar and Khan, 2013; Khudhair *et al.*, 2019). Information on this vital water body is primarily on its water variability, while macroinvertebrates studies are lacking (Ezemonye *et al.*, 2016; Onyeche and Akankali, 2013). Thus, macroinvertebrate studies of this vital river are of urgent importance for the maintenance and management of the river. The design of this study investigates the composition and abundance of macroinvertebrates of Anwai River and evaluate the impact of anthropic activities in the river.

Materials and methods

Study Location and Sampled stations

River Anwai has an estimated terrain elevation of thirty-seven (37) meters, located between latitude 6° 14′ and longitude 6°42′, originating from the hilly landforms of Otulu and emptying its waters into the River Niger at Asaba by flowing through Isele-Azagba and Okpanam communities. The drainage is a rain forest area, while the river flow is provided for by underground water supply and heavy precipitation associated. Having unlimited accessibility and different human activities. This study focused on the upper and lower sections of the river with unlimited accessibility and intense human activity. This study marked out three study sites; Otulu, the upper section of the River, designated Station 1. Station 2 is mid-way between Stations 1 and 3 while the third station at Asaba is the lower section of River Anwai.

Otulu (Station 1)

This station located in Otulu town and manually dredged to increase swimming depth and rapid unidirectional flow. The river in this region has a narrow channel. The location has dense riparian vegetation cover limiting direct light penetration. The vegetation such as *Musa paradisiaca* L. (Pro sp*), Ficus elastic* Roxb. ex Hornem*, Bambusa vulgaris* Schrad. ex J.C.Wendi, *Attalea brasiliensis Glassman, Mangifera indica* L. and other wild tree species found in the watershed provided covers by trees. At the same time, *Pontederia cordata* L. and *Eichhornia crassipes* (Mart) Solms represent the emergent plants bordering the shores of the river. The River's deity shrine prohibits unchecked visitation. Such prohibitions help reduce human activities at this station except bathing and washing of clothes by adult males only sacrificing to the river goddess.

Otulu-Asaba (Station 2)

Station 2 is open water situated mid-way between stations 1 (Otulu) and 3 (Asaba), approximately 100m away from station 1. The river section in this region is unregulated (neither dredged nor channelled). Depth very shallow, with the characteristic rapid and pool regions of a river present. The stream bed of the sampled point filled with silts, with the profuse smell of decaying materials from human activities origins such as dishes and clothes washing, bathing by women, teenagers and children, human and cattle defecation, water drinking source for cattle. The vegetation cover here is more than station 1, significantly reducing sunlight penetration into the river. In-stream plants were absent at this station. *B vulgaris*, *A. brasiliensis* and *M. indica* as the most dominant plants at the station.

Asaba (Station 3)

Station 3 located at the entrance of Camp 74's fish farm, close to Anwai Bridge, a highly populated town. This region of the river channelized to receive drainage water from; Government house, Anwai road, Core area and Okpanam road all in Asaba the capital city of Delta State. The River at this point measuring over 6ft at the deepest point, fast-flowing downstream and devoid of canopy cover, however, noticeable on the shallow fringes are some emergent vegetation such as *Alternanthera philoxeroides* (Matt) Griseb and *Nymphaea* spp L..

Macroinvertebrate sampling

Macroinvertebrate community of River Anwai was sampled, by a slight modification of the kick method using a D-frame dragnet. At each station, the edge of the river immediately upstream of the position of the net is disturbed by kicking the substratum and aquatic plants present to dislodge any macroinvertebrate attached. A 600µm mesh size D-frame net located downstream from the point of disturbance positioned to collect the dislodged debris. The process lasts for about 3mins and repeated at three different locations within the sampling station to increase the chance of collecting all possible organism at the station. The samples collected in the net transferred into a plastic collecting bag, before adding 10% formalin solution as a preservative. The preserved samples transported to the Hydrobiology Laboratory of the Department of Animal and Environmental Biology, Delta State University, Abraka. Where the samples were filtered through a sieve of about 500µm mesh size to remove silt. The macroinvertebrate organisms were then sorted identified to the lowest possible taxa and counted. Identification of macroinvertebrates made using charts provided by Merrit and Cummins 1999; Water and rivers Commission (2001), Barber-James and Lugo-Ortiz (2003).

Statistical Analysis

ANOVA (one way) was used to establish is the data collected from the various stations varied significantly. In contrast, Pearson linear correlation performed to establish any relationship between water quality parameters and Macroinvertebrate community in Anwai River. Macroinvertebrate community structure was measured by determining the Shannon-Weiner, Menhinick, Margalef and Simpson dominance indices with the aid of PAST statistical analytical software (Hammer *et al.*, 2001).

Results

The outcome of the physicochemical analysis presented in Table 1 indicates low range values for most parameters except depth across the various stations. Visual inspection of these results seemingly shows similar values.

However, one-way ANOVA evaluation detected three physical and chemical parameters, respectively differed significantly between the locations ($p<0.05$) (Table 1).

Table 1. Mean value ± standard error (S.E), F- and P- values of some measured aquatic parameters of the different stations in Anwai River.

Parameters	Station 1	Station 2	Station 3	F – value	P- value
Air Temp	29.57±1.81 (28-33)	28.48±1.62 (26-30)	30.43±1.90 (28-33)	2.22	0.1375
Water Temp	27.71±0.49 (27-28)	27.00±1.53 (24-28)	25.71±2.14 (22-28)	3.02	0.074*
Water depth	22.86±1.35 (20-24)	15.71±0.81 (14-16.1)	75.43±10.88 (56-88)	184.9	9.98E-13*
TDS	15.5714±1.13 (14-17)	15.2857±0.95 (14-16)	8.57±0.54 (8-9)	133.1	1.64E-11*
pH	6.71±0.61 (5.9-7.2)	6.27±0.61 (5.4-7.3)	6.93±1.13 (5.3-8.2)	1.17	0.3329
D.O	2.27±0.11 (2.2-2.5)	2.23±0.13 (2.1-2.5)	2.04±0.68 (2.0-2.2)	9.042	0.0019*
BOD	1.41±0.50 (1-2.4)	1.41±0.24 (1.1-1.9)	1.39±0.23 (1.2-1.9)	0.0157	0.9844
Turbidity	2.46±0.17 (2.3-2.7)	3.00±0.12 (2.8-3.1)	3.36±1.83 (0.5-5.2)	1.275	0.3035
Alkalinity	3.99±1.25 (3.00-5.8)	4.03±1.57 (1.6-6.2)	7.03±1.14 (5.8-9.2)	11.95	0.0005*
Nitrate	0.13±0.05 (0.1-0.2)	0.16±0.10 (0.1-0.3)	0.19±0.11 (0.1-0.3)	0.7347	0.4933

Air Temp – Air Temperature; Water Temp - Water Temperature; TDS- Total Dissolved Solids; DO- Dissolved solids; BOD-Biochemical Oxygen Demand.

Table 2. Composition, Spatial Distribution and Relative Abundance (RA) of the macroinvertebrate community at different sampling sites.

Order	Family	*Species*	STN1D	STN2NDCH	STN3CH	Total	RA
Gastropoda	Pilidae	*Pomacea bridgesii*	-	-	+	3	0.65
Odonata							
	Libellulidae						10.42
		Perithemis tenera (Say, 1839)	++	+	+	21	
		Pantala flavesens(Fabricius,1798)	-	-	+	1	
		Celithemis sp	-	++	-	13	
		Erythemis simplicicollis (Say, 1839)	+	-	+	9	
		Arigomphus pallidus(Rambur,1842)	+	+	+	5	
	Megapodagrionidae	*Ischnura sp* Charpentier,1840	+	+	+	10	2.17
	Corduliidae	*Sympetrum flaveolum* Linnaeus,1758	+	-	+	4	0.87
Sub-total			**25**	**22**	**16**	**63**	
Coleoptera	Dytiscidae	*Cybister sp* Curtis 1827	+	+	-	5	1.09
Hirudinada	Hirudinidae	*Hirudo medicinalis*	-	+	-	2	0.43
Diptera	Chironomidae	*Chironomus plumosus*	-	+++++	++++	302	65.51
Hemiptera							
	Naucoridae	*Pelocoris femoratus*(Palisot de Beauvois,1820	+	-	++	18	3.91
	Corixidae	*Corixa punctate* (Illiger, 1807)	+	+	-	7	1.52
	Nepidae		+				11.28
		Nepa cinerea Linnaeus,1758	+	+	+	11	
		Ranatra linearis	++	+++	+	41	
	Gerridae	*Aquarius remigis*	-	-	+	5	1.09
Sub-total			**21**	**38**	**23**	**82**	
Decapoda	Palaemonidae	*Macrobrachium vollenhovenii* (Herklots)	+	-	+	4	0.87
Grand Total			**50**	**256**	**155**	**461**	

1-10 (+); 11-20 (++); 21-30 (+++); 100-110 (++++); 111-200 (+++++); STN1D-Station 1Dredged; STN2NDCH-Station 2Neither dredged or channeled; STN3CH-channeled.

The study identified a total of four hundred and sixty-one macrobiota. Individuals categorized into seven taxonomic groups, thirteen families and seventeen distinct species. The taxa richness varied from 5-7 in numbers. Station 1; the dredged station had 50 individuals from eleven species and eight families. Station 2(neither dredged nor channelized) recorded two hundred and fifty-six individuals (256), from ten species and eight families. While station 3(channelized), recorded one hundred and fifty-five individuals, from thirteen species and ten families. The number of taxa was visually similar; however; the macroinvertebrate population was more or in the un-channelized portion of the river. The invertebrate fauna in Station 2 is 75% Diptera (Chironomus plumosus Linnaeus, 1758) and 71% in channelled and absent in the manually dredged section.

In terms of abundance, the Diptera was the most abundant with 302 individuals, followed by Hemiptera, 82 individuals, Odonata 63, coleopteran 5, Decapoda 4, Gastropoda 3, and Hirudinea 2. Only Odonata and Hemiptera have a river wide coverage as they were both recorded at all the three sampled stations. The Gastropoda was limited to station 3 alone, while Hirudinea was limited to station 2. Coleopteran was found in stations 1 and 2, while decapods were reported only in stations 1 and 3. *Aquarius remiges* Say, 1832 *and Pomacea bridgesii* (Reeve, 1856) found exclusively in station 3. In contrast, *Celithemis* sp (Hagen, 1861) and *Hirudo medicinalis* Linnaeus, 1758, restricted to station 2, and others cosmopolitan. Table 3, represents the results of the analysis of diversity indices of Anwai River at the three stations. The values for all measured indices were less than 1. Evenness was highest at station 1 (0.6516) followed by station 3 (0.4987), and least was station 2 (0.4338).

Table 3. Measured diversity indices recorded in Anwai River.

Diversity Parameters	station1	Station 2	Station 3
Taxa_S	4	5	5
Individuals	50	256	155
Dominance_D	0.4304	0.592	0.5371
Simpson_1-D	0.5696	0.408	0.4629
Shannon_H	0.958	0.7856	0.9136
Evenness_e^H/S	0.6516	0.4388	0.4987
Margalef	0.7669	0.7213	0.7931

Correlation between Physicochemical Parameters and Macroinvertebrates

The analysis of correlation of macroinvertebrates with physic-chemical parameters shown below showed that water temperature negatively correlated with most physic-chemical parameters for TDS, D.O and BOD.

There was also a strong negative correlation between water temperature and macroinvertebrate groups Gastropoda and Decapoda. Water depth had a negative correlation with most macroinvertebrate groups except Gastropoda and Decapoda at 0.99398 and 0.97508. pH highly correlated with D.O and B.O.D (-0.62362 and -0.75063); however, it positively correlated with alkalinity, Gastropoda and Decapoda. A robust correlation found Coleopteran and Odonata, TDS, water temperature, D.O and BOD. Gastropoda also had an extreme negative correlation in water temperature, TDS, D.O and BOD. The highest positive correlation value between BOD and Gastropoda (1). The highest negative correlation value (-1) established between Coleopteran and Odonata.

The cluster analysis isolated Station 1 from stations 2 and 3. Odonata and Hemiptera vary along the pH, TDS, alkalinity, air and water temperatures, depth (Fig. 1). The distribution, abundance of dipteran discriminated among stations.

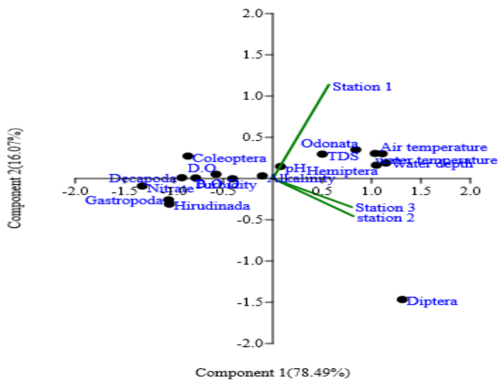

Fig. 1. The biplot representation of the first two coordinates representing 94.56% of the impact of the studied physicochemical parameters and macroinvertebrate abundance at the various stations.

Table 4. Result of correlation analysis between physico-chemical parameters and macroinvertebrate community of Anwai River.

	AT	WT	WD	TDS	pH	DO	BOD	Turb	Alka	Nitr	Gastr	Odon	Cole	Hiru	Dipt	Hemi	Dec
AT		0.61	0.31	0.40	0.08	0.49	0.38	0.79	0.39	0.71	0.38	0.83	0.59	0.29	0.68	0.36	0.17
WT	-0.58		0.30	0.21	0.69	0.12	0.23	0.18	0.22	0.10	0.23	0.01	0.02	0.89	0.72	0.96	0.44
WD	0.89	-0.89		0.09	0.39	0.18	0.07	0.48	0.08	0.40	0.07	0.28	0.28	0.60	0.98	0.67	0.14
TDS	-0.81	0.95	-0.99		0.48	0.09	0.02	0.39	0.02	0.31	0.02	0.19	0.19	0.69	0.92	0.76	0.24
pH	0.99	-0.47	0.82	-0.73		0.57	0.46	0.87	0.47	0.79	0.46	0.67	0.67	0.21	0.59	0.28	0.25
DO	-0.72	0.98	-0.96	0.99	-0.62		0.11	0.30	0.10	0.22	0.11	0.10	0.10	0.78	0.83	0.85	0.32
BOD	-0.83	0.94	-0.99	1.00	-0.75	0.99		0.41	0.01	0.33	0.00	0.21	0.21	0.67	0.95	0.74	0.21
Turb	0.33	-0.96	0.73	-0.82	0.21	-0.89	-0.80		0.40	0.08	0.41	0.20	0.20	0.92	0.54	0.86	0.62
Alka	0.82	-0.94	0.99	-1.00	0.74	-1.00	-1.00	0.81		0.33	0.01	0.20	0.20	0.67	0.94	0.74	0.22
Nitr	0.44	-0.99	0.81	-0.88	0.32	-0.94	-0.87	0.99	0.87		0.33	0.12	0.12	1.00	0.61	0.93	0.55

	AT	WT	WD	TDS	pH	DO	BOD	Turb	Alka	Nitr	Gastr	Odon	Cole	Hiru	Dipt	Hemi	Dec
Gastr	0.83	-0.94	0.99	-1.00	0.75	-0.98	-1	0.80	1.00	0.87		0.21	0.21	0.67	0.95	0.74	0.21
Odon	-0.60	1.00	-0.90	0.96	-0.49	0.99	0.94	-0.95	-0.95	-0.98	-0.94		0.00	0.88	0.73	0.95	0.42
Cole	-0.60	1.00	-0.90	0.96	-0.49	0.99	0.94	-0.95	-0.95	-0.98	-0.94	1		0.88	0.73	0.95	0.42
Hiru	-0.90	0.16	-0.59	0.47	-0.95	0.34	0.5	0.12	-0.49	-0.00	-0.5	0.19	0.19		0.39	0.07	0.45
Dipt	-0.49	-0.43	-0.03	-0.12	-0.60	-0.26	-0.08	0.66	0.10	0.57	0.08	-0.41	-0.41	0.82		0.32	0.84
Hemi	-0.85	0.06	-0.50	0.37	-0.91	0.24	0.40	0.22	-0.39	0.11	-0.40	0.08	0.08	0.99	0.90		0.52
Dec	0.97	-0.75	0.98	-0.93	0.93	-0.87	-0.94	0.56	0.94	0.66	0.94	-0.79	-0.79	-0.76	-0.25	-0.68	

AT-Air Temperature; WT- water temperature; WD-water depth; TDS-total dissolved solids; pH-hydrogen ion concentration; DO-dissolved oxygen; BOD-biochemical oxygen demand; Turb- turbidity; Alka-Alkalinity; Nitr-Nitrate; Gastr- Gastropoda; Odon- Odonata; Cole-Coleoptera; Hiru-Hirudinea; Dipt-Diptera; Hemi-Hemiptera; Dec-Decapoda.

Discussion

There have been no previous studies of this nature on Anwai River; however, similar water quality findings with earlier research by Ezemonye *et al.* (2016) at measuring the impact of Abattoir waste on Physico-chemical parameters of the River. These similarities confirm the introduction of organic pollutants into the river not abated, concealing the impact of channelization (USEPA, 2011). Elsewhere, in Aleto Tiver, Egobueze *et al.* (2011) also reported a similar range of values for most water quality parameters in an Anthropocene-impacted river. The quality of any water body is a function of its water parameters, which is a product of the interaction between the physical-geomorphological characteristic of the watershed and dominant anthropogenic activities in this environment. The water temperature recorded in this study was well within the range recorded for rivers in the tropics (Ezemonye *et al.*, 2016; Iloba *et al.*, 2019; Iloba and Akpoyibo, 2019). There was no significant variation in the spatial water temperature during this study; however, a noticeable trend between the water temperature and air temperature existed, similar to the records of Iloba *et al.* (2018). The observed trend attributed to the inefficiency of heat transfer from the environment to the water body. Although, Morrison *et al.* (2012) reported that "increasing water temperatures affect the self-purification capacity of rivers by reducing the amount of oxygen that can be dissolved in it and used for biodegradation. The low levels of dissolved oxygen and relatively high biochemical oxygen demand in this study did not reflect the high water flow in the river, particularly in station 3. The low oxygen level, therefore, undermines the degree of human activities, influx of organic matter from human and animal faecal matter, abattoir waste into Anwai River. The oxygen content inferred Anwai River is perturbed. The low oxygen nature of the river possibly sustained by high tropical temperature (Moorison *et al.*, 2012), explainable by the high correlation between water temperature and dissolved oxygen(r=0.98) Table 4. The high temperature prevalent in tropical freshwater bodies with a high influx of organic matter reflects low pH levels. This study noted a similar trend and conforms to the reports of Egobueze *et al.*, (2011) in Aleto River in the Niger Delta region. The acidic nature of the river prevents the dissolution of nitrate impacting low concentration of nitrate in the River despite the influx of nitrate-laden organic matter from the agrarian watershed probably due to humic substances prevalent in aquatic plants (Akinremi *et al.*, 2016). The maintenance of the Nitrate level in this study below the minimum level 10.0mg/L recommended by Federal Ministry of Environment water quality criteria could be labelled self-purification of the river.

The non-availability of pre and post-channelled studies on the river makes it difficult to infer the impacts of these activities on the macroinvertebrates directly. However, when compared with the rivers within the same geographical region, the river is inferior macroinvertebrate composition and abundance. The number (16) of macroinvertebrate recorded in Anwai River is less than the records of Arimoro and Keke (2017) with forty-one (41) taxa. However; it pooled in more individuals than Iloba *et al.*, (2018 and 2019). The low abundance of the organisms observed in this study is valid for channelled Rivers due to loss of habitat heterogeneity (USEPA, 2011). Kennedy and Turner (2011) also reported a lower number of benthic macroinvertebrates in the channelled reaches of Rio Grande River, associated with loss of habitat. The low number of benthic biota in the present study supports the assertion of negative impacts of river channelling on macroinvertebrates in the dredged and channelled river and even substantially beyond the channelled zone (USEPA, 2011) evident in station 2 (Smith *et al*., 2019). The present study substantiates that the channelled sampling sites, organically troubled water low in pH are macroinvertebrates impoverished. Studies have made similar apparent assertions in organically rich acidic freshwater bodies. The variation of the organisms along a low pH gradient in this study adversely affected benthic macroinvertebrate community structure and the richness of EPT groups within the community (Baldigo *et al*., 2009).

Furthermore; pH also highlighted as an important variable associated with community structure of benthic macroinvertebrates (Sandin (2003). the predominance of Odonata and Hemiptera in Anwai River not favoured in richness due to habitat loss. Although the Odonata had a higher number of species, the Hemiptera were numerically more abundant with 82 individuals to 63 individuals recorded by Odonata. *Ranatra linearis (*Linnaeus, 1758) contributed nearly half of the numbers recorded for the Hemiptera with 41 individuals. The abundance of Hemiptera in Anwai River is similar to that recorded by Iloba *et al*. (2019) in Ethiope River. According to Choudhary and Ahi 2015, Hemiptera can do well in moderately polluted freshwater due to their ability to maintain their community in freshwater with low dissolved the observed trend oxygen concentration, however, hinder by habitat disintegration. The dominance of Odonates in this study is similar to that noticed by Arimoro *et al.* (2015) at Ogbe River. The prevalence of the Odonates attributed to the presence of vegetation cover provides them with the required habitats for their survival. This research hence supports this assertion that the odonates in Anwai River were more abundant in stations 1 and 2, with more vegetation cover than the other station. Braccia *et al.* (2007), reported that Odonata is the early colonizers of new lentic habitats. Their ability to colonize new environments probably contributed to the abundance and survival in the environment. The result of this study revealed Diptera to be the most significant contributor to the macrobenthic community in Anwai River. The Chironomus remained by far more individuals than all other taxa put together. The dominance of Diptera (Chironomus) in the macroinvertebrate communities is prevalent in organically laden water. The abundance and dominance of Chironomus in station 2 impacted by abattoir waste, open defecation by humans and cattle alike around the riparian and ephemeral water zones of Anwai River, and is suggestive of the river is heavily polluted. The low flow and high silt deposit in the substratum create a further favourable environment for the abundance of Diptera and Oligochaete. While their abundance in station 3 is not unassociated with the organic waste from the abattoir located there. These claims further strengthened by the reports of Andem *et al.* (2014) who associated the abundance of Oligochaete and Chironomidae with organic pollution in the aquatic environment of the Niger Delta.

Furthermore, harsh environmental conditions such as the low pH this channelled water river, combined with the fast generation times of blood worm contributed to their dominance over other taxa in this study (Merritt and Cummins, (1999). Low diversity indices in the present study are associated with organic interferences from anthropogenic activities (Ikomi and Arimoro, 2014; Iloba *et al*., 2019). Low values for all indices of diversity measured in Anwai River, confirmed earlier claims that the river is organically disturbed as a result of the human activities going on in and around the river. The higher values of Shannon-Weiner, evenness and Margalef indices in stations 1 and 3, than in station 2, is an indication that channelled portions of Anwai River improved the water quality. This improvement is due to the increased water flow at these points.

Low values for specific water quality parameters such as pH and dissolved oxygen, the fauna abundance, diversity indices (all less than 1.0), and long records of blood worms inferred Anwai River a threat not just the life forms in the water but also to humans utilizing the river water. Although the channelled regions of this river noted a slight improvement, it is still necessary to monitor, stop or reduce human activities capable of polluting this river further. Efforts to channel the entire length of Anwai River is a must to avoid an outbreak of the waterborne disease in the riparian communities.

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