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Density Diversity Assessment Of Macroinvertebrates Of River Illah, Delta State, Nigeria

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ABSTRACT: The inquiry was directed at estimating the even nature of diversity to density quotient of macro benthic invertebrates at River Illah. Macro benthic invertebrates were obtained using kick sampling techniques while water samples were quantified using standard methods of analysis. Results divulge that Odonata and Crustacea were preponderant consisting (18.45%) of total abundance. Waters from River Illah were well oxygenated (5.2 - 6.8 mg/l), contained low BOD_5 (2.4 – 3.5 mg/l) and had a moderate flow rate (0.11 – 0.25 m/s). Generally, 26 taxa in total were encountered from the 6 months sampling (March – August, 2016) with only *Polymorphanisus bipunctatus* (Tricoptera species) occurring at all sampled stations. Presence of Ephemeroptera, Zygoptera and Tricoptera in abundance and low abundance of Diptera (8.74%) portends the water body to be of fairly good quality.

Keywords: Diversity, Density, Macroinvertebrates distribution and River Illah.

1. Introduction

The quest of unraveling the mysteries of events within the potency of macro benthic fauna and their habitat have prompted researchers over decades to outline the ecological cogency, potential diversities, anthropogenic powers and the succession of known aquatic ecosystems within the globe. Macro invertebrates which are used as bio-indicators are high water marked invertebrates that are integrated with life at the depth of streams, ponds, lakes either crawling burrowing or attached to various kinds of solidified objects like plants, stones and hauled woods. These macro benthic assemblages include coleopterans, Dipterans, Ephemeropterans, Hemipterans, Odonats, Tricopterans, Plecopterans, Arachnids, Annelids, Nematodes and other heterogeneous classes of macro benthic orders.Anthropogenic activities including the excessive use of fertilizer for agricultural activities and the dump of human organic waste in water body can threaten the health of any water body (Okeke and Igboanua, 2003). Everyone desires water not only considered pure but free from disease agents particularly in communities where households are disposed to using the available. Most households in rural areas of southern Nigeria use water from rivers withoutcarrying out proper investigation on the palatability and suitability. Macro invertebrates that dwells in bottom of rivers have not been excluded in thevital role they play in pollution discoveries and water health security for stream bodies. Their functions cannot be trivial in nature due to their extensive use in water researches by hydro-biologists. No study exist for a ready to use water body at Illah and this stroked the needfor this study to estimating the even nature of diversity to diversity quotient of macro benthic invertebratesas a requisite to investigate the standard of waters from River Illah.

2. Description of study area

The study was conducted at River Illah which is about 60km from the metropolis and geographically located in Oshimili North Local Government Area of Delta State. River Illah is on the west bank of River Niger a far mile north of a straight line from Benin City and Enugu. River Illah is a tributary from Anwai River and it is fed primarily with water from several branches, surface run offs from riparian plants and finally empties it content directly into River Niger in Delta – Anambra state.

2.1. Sampled stations

Three sampled sites were established along the longitudinal stretched course of the river, Station I (the undisturbed site), station II (the site with dense anthropogenic activities) and station III (site with slight human activities)

2.1.1. Station I: is located upstream of the river, vegetation is derived and a narrow channel. The site is vegetated with *Bambosa spp* and is bedded with a muddy and strong clayey floor. The site is considered the null site for the research.

2.1.2. Station II: this is the site with dense anthropogenic activities like swimming, fishing and laundry wash. It is 10 feet away from station I, it is dominated by river weeds; stream bed is muddy at corners and sandy at centre. The site is clear of riparian vegetation, shallow with fluctuating depth and width.

2.1.3. Station III: it is located downstream; it is also 10 feet away from station II and with reduced human activities. The site is fully shredded with trees which reduced the direct effects of sunlight.

2.2. Water sample analysis

Water samples were collected within the experimental periods from each station, using a clean round bottom flask. Water was collected at a depth of 0.07m from the surface and opposite to water current. Water samples were transported to the department of animal and environmental biology laboratory, Delta State University, Abraka for water – chemical analysis following standard methods of preparation to determine Biological oxygen demand (BOD_5), Nitrate – nitrogen, Phosphate – phosphorus, Dissolved oxygen, Hydrogen ion concentration (pH).

2.3. Macro invertebrate sampling

Macro benthic invertebrates was sampled using a rectangular frame net, scoop nets and sieves of 500nm hole diameter. Rectangular net of 40cm x 32cm frame was positioned at various depths in opposite direction of water current as river bed is disturbed with the feet to dislodge macroinvertebrates at each substratum. Sampled were collected and transferred from the net into a white bowl containing alcohol about 70% for sorting procedures afterwards macroinvertebrates were transferred into a cocked jar and transported to the Delta State University, Abraka laboratory for microscopic identification and counting. Identification was aided using a key provided in Macan (1959) and Pennak (1998) possible taxonomic lever.

2.4. Data analysis

Water samples were subjected to analysis of variance (ANOVA), while monthly percentage of numerical abundance was obtained; samples were subjected to spearman correlation with selected physicochemical parameters and species richness indices – Shannon Wiener index represented in equation I, Margalef index in equation II and density in equation III were also employed.

$$Hs = \sum \frac{Nilog\ Ni}{N} \text{(Shannon Weiner index, 1949)} \quad \text{.....I}$$

$$\text{Density} = \frac{Total\ number\ of\ species\ in\ sample}{Area\ of\ sampling\ unit} \quad \text{.....II}$$

$$D = \frac{S-1}{LogN} \text{ (Margalef index, 1967)} \quad \text{.....III}$$

3.0. Result

Table 3.1 discloses the summary of the mean values of the various chemical parameters monitored at the different selected sampled stations within durations of six months (March – August, 2016) along the river. Amongst selected parameters, Air and water temperature, dissolved oxygen, hydrogen ion concentration (pH), and nitrate were not significant within the three sampled stations ($p > 0.05$) whilst, flow velocity, conductivity, Biochemical oxygen demand (BOD_5) and phosphate were significantly different ($p < 0.05$) within sampled stations.

Table 3.1 *Summary of some physical and chemical parameters of the sampling stations of River Illah, Delta State, Nigeria from March to August, 2016*

S/N	Parameter	Station 1	Station 2	Station 3	F-ANOVA		P-probability	
					months	stations	months	stations
1.	Air temperature (°C)	29.45±0.31 (28.2–30.10)	29.45±0.42 (28.10– 31.1)	29.45±0.39 (28.30-30.50)	11.74*	2.9	0.0001	0.101
2.	Water temperature (°C)	27.25±0.28 (26.40-28.10)	27.62±0.26 (27.0-28.60)	27.53±0.29 (26.50-28.50)	8.5*	2.4	0.003	0.138
3.	Flow velocity (m/s)	0.18±0.02 (0.11-0.22)	0.20±0.02 (0.12-0.24)	0.22±0.01 (0.18-0.25)	12.9*	16.2*	0.0004	0.0007
4.	Conductivity (µS/cm)	17.35±0.86 (14.30-19.70)	17.10±0.59 (15.0-18.79)	15.28±0.34 (14.30-16.21)	9.8*	13.58*	0.0009	0.0014
5.	Dissolved oxygen (mg/L)	5.88±0.25 (5.2-6.8)	5.88±0.17 (5.2-6.5)	6.03±0.21 (5.4-6.8)	9.3*	1.17	0.002	0.35
6.	Biochemical Oxygen demand (mg/L)	2.77±0.10 (2.5-3.1)	3.13±0.12 (2.7-3.5)	2.65±0.09 (2.4-2.9)	15.2*	12.7*	0.0002	0.0003
7.	pH	5.5 (4.9-5.7)	5.3 (5.0-5.5)	5.7 (5.4-6.1)	14.7*	1.8	0.001	0.21
8.	Nitrates (mg/L)	0.04±0.01 (0.02-0.05)	0.04±0.01 (0.02-0.06)	0.04±0.01 (0.02-0.05)	7.6*	0.11	0.004	0.90
9.	Phosphate (mg/L)	2.64±0.03 (2.56-2.72)	2.57±0.04 (2.45-2.69)	2.16±0.02 (2.10-2.23)	12.2*	71*	0.0005	12E-05

Note: values are means ± standard Error, minimum and maximum values are given in parentheses. * indicates significant difference (P<0.05) by ANOVA

3.1. Density – diversity cum physiochemical review

The density diversity of the sampled fauna was extremely low; 26 taxa were recorded (table 3.4). Odonata and Crustacea dominated the overall density (18.56% and 18.95%) and (18.45%) of the total abundance while only one *Polymorphanisus bipunctatus*(Tricoptera species) occurring at the various sampled stations (Table 3.4). More than 80% of the samples were insects and their developmental stages(larvae) while only 0.98% of mollusk was encountered. Although, flow velocity rate were moderate (0.11 – 0.25 m/s), water was slightly acidic (4.9 – 6.1), well oxygenated (5.2 – 6.8 mg/l) and contained low biological oxygen demand (BOD_5) (2.4 – 3.5 mg/l). With respect to monthly sampling, Kruskal-Wallis test reveals that there were no significant differences ($p > 0.05$) in the percentage density of macro-benthic invertebrates obtained from March through August (Transitional periods) at River Illah. Similarly, single factor ANOVA showed no significance with

respect to percentage density; between ($F_{critical}$ = 2.4085, df = 5, $F_{calculated}$ = 1.18998) and within densities.

3.2. Macro invertebrates cum Physiochemical correlations

Macro invertebrates – Physiochemical correlations (selected: Dissolved oxygen, flow velocity, hydrogen ion concentration and water temperature) on density diversity are represented in table 3.3. Statistically, following spearman rank correlation, Decapoda exhibited high significant difference ($p < 0.05$) with both flow velocity and dissolved oxygen, while mollusk displayed statistical significance ($p < 0.05$) with dissolved oxygen alone. Water temperature had negative correlative effect with Odonata, tricoptera and Hemiptera while flow velocity exhibited negative effect on Tricoptera, Hemiptera and Diptera; hydrogen ion concentration (pH) showed negative correlative effects on Ephemeroptera, Tricoptera, Diptera and Hemiptera while Dissolved oxygen had negative correlative effects on Tricoptera alone. Therefore, in representing the percentage of macro invertebrates density diversity in order of decreasing bio–sensitive complexities, we have Decapoda > Odonata >Ephemeroptera >Coleoptera >Zygoptera >Tricoptera.

Table 3.2 *Summary of the percentage density composition of all the macro invertebrate orders sampled at River Illah, Delta State, Nigeria from March to August, 2016.*

Order	March	April	May	June	July	August
Odonata	2.93(0.60)	2.54(0.52)	3.91(0.80)	3.91(0.80)	4.49(0.92)	0.78(0.16)
Coleoptera	2.15(0.44)	1.37(0.28)	2.54(0.52)	2.54(0.52)	3.71(0.76)	1.37(0.28)
Zygoptera	0.59(0.12)	1.17(0.24)	1.95(0.40)	2.73(0.56)	3.13(0.64)	1.95(0.40)
Tricoptera	1.95(0.40)	1.37(0.28)	2.15(0.44)	2.15(0.44)	1.95(0.40)	1.17(0.24)
Hemiptera	0.39(0.08)	0.59(0.12)	0.78(0.16)	0.59(0.12)	0.39(0.08)	0.00(0.00)
Ephemeroptera	1.76(0.36)	1.76(0.36)	2.73(0.56)	3.13(0.64)	2.73(0.56)	1.95(0.40)
Decapoda	1.56(0.32)	1.56(0.32)	3.32(0.68)	3.52(0.72)	4.49(0.92)	4.49(0.92)
Mollusca	0.39(0.08)	0.39(0.08)	0.20(0.04)	0.00(0.00)	0.00(0.00)	0.00(0.00)
Diptera	2.34(0.48)	1.37(0.28)	1.17(0.24)	0.98(0.20)	1.37(0.28)	1.76(0.36)

Note: values are percentage density of the sampled stations while values in bracket are the densities of the macro invertebrates sampled.

Table 3.3 *Summary of the physiochemical correlation against all the macro invertebrate orders sampled at River Illah, Delta State, Nigeria from March to August, 2016*

Order	DO	F/V	pH	WT (°C)
Odonata	0.1214	0.0857	0.3429	-0.0429
Coleoptera	0.1286	0.2143	0.2571	0.1143
Zygoptera	0.7286	0.7500	0.1143	0.2429
Tricoptera	-0.5429	-0.1857	-0.1714	-0.1143
Hemiptera	0.4643	-0.3429	-0.2714	-0.3429
Ephemeroptera	0.4714	0.5143	-0.2143	0.2000
Decapoda	*0.9429	*0.9571	-0.0143	0.6286
Mollusca	*0.9714	0.8286	0.2286	0.5000
Diptera	0.2428	-0.2429	0.1429	0.1857

Note: * indicates significant difference (P<0.05) by spearman correlation, DO = dissolved oxygen, F/V= flow velocity, pH= hydrogen ion concentration, WT= water temperature

Table 3.4 *Summary of taxa composition, abundance and distribution of macro invertebrate orders sampled at River Illah, Delta State, Nigeria from March to August, 2016*

Order	Taxa	Station 1	Station 2	Station 3
Odonata (Anisoptera)	*Cordulia spp*	11	11	0
	Lestinogomphus spp	0	18	17
	Gomphus spp	0	9	10
	Aeschna spp	0	0	19
Odonata (Zygoptera)	*Coenagrion spp*	0	15	15
	Chlorocyphidae	0	0	29
Coleoptera	*Canthyporus spp*	22	7	0
	Parecnomina spp	0	15	0
	Philodytes spp	20	0	0
	UnidentifiedBettlespp	0	0	6
Tricoptera	*Polymorphanisus bipunctatus*	10	10	10
	Psychomyia spp	0	17	0
	Hydropsyche spp	0	5	0
	Philopotamus spp	0	4	0
Hemiptera	*Micronecta spp*	0	8	0
	Belostoma spp	0	6	0
Ephemeroptera	*Baetis bicaudatus*	0	4	36
	Adenophleboides spp	0	18	14
Decapoda	*Caridina nilotica*	24	15	0
	Caridina gabonensis	29	0	0
	Caridina africana	0	20	0

	Potamolpheops monodi	0	7	0
Mollusca	*Sphaerium spp*	0	0	5
Diptera	*Culex spp*	0	4	0
	Chironomus transvaalensis	0	41	0
	Oligoneuria spp	0	0	0
No of Species		**6**	**19**	**10**
Total no of Ind.		**116**	**234**	**161**

Table 3.5 *Showing monthly distributions of macro invertebrate orders sampled at River Illah, Delta State, Nigeria from March to August, 2016*

Order	Family	Species	March	April	May	June	July	August	Total
Odonata (Anisoptera)	Corduliidae	*Cordulia spp*	4	3	5	4	5	1	22
	Libellulidae	*Lestinogomphus spp*	5	6	6	8	8	2	35
	Gomphidae	*Gomphus spp*	3	2	4	4	6	0	19
	Aeshnidae	*Aeschna spp*	3	2	5	4	4	1	19
Odonata (Zygoptera)	Coenogrionidae	*Coenagrion spp*	2	3	6	7	8	4	30
	Chlorocyphidae	Unidentifiedspp	1	3	4	7	8	6	29
Coleoptera	Dysticidae	*Canthyporus spp*	3	3	5	6	8	4	29
	Parecnomina	*Parecnomina spp*	3	2	3	3	4	0	15
	Urothermis	*Philodytes spp*	3	2	3	4	6	2	20
	Bettle	UnidentifiedBettle	2	0	2	1	1	0	6
Tricoptera	Psychomyiidae	*Psychomyia spp*	2	2	3	4	4	2	17
	Hydropsychiidae	*Hydropsyche spp*	1	1	1	0	2	0	5
	Philopotamidae	*Philopotamus spp*	2	1	1	0	0	0	4
	Philopotamidae	*Polymorphanisus bipunctatus*	5	3	6	7	5	4	30
Hemiptera	Corixidae	*Micronecta spp*	1	2	2	2	1	0	8
	Belostomatidae	*Belostoma spp*	1	1	2	1	1	0	6
Ephemeroptera	Baetidae	*Baetis bicaudatus*	5	5	8	10	8	4	40
	Leptophlebiidae	*Adenophleboides spp*	4	4	6	6	6	6	32
Decapoda	Atyidae	*Caridina nilotica*	2	4	7	6	12	8	39
	Atydae	*Caridina gabonensis*	1	2	4	6	10	6	29
	Potamonatidae	*Caridina africana*	3	2	4	3	4	4	20
	Palaemonidae	*Potamolpheops monodi*	2	0	2	1	1	1	7
Mollusca	Sphaeriidae	*Sphaerium spp*	2	2	1	0	0	0	5
Diptera	Culicidae	*Culex spp*	2	1	1	0	0	0	4
	Chironomidae	*Chironomus spp*	10	6	5	5	6	9	41
	Oligoneoridae	*Oligoneuria spp*	0	0	0	0	0	0	0
Total Species			**72**	**62**	**96**	**99**	**118**	**64**	**511**

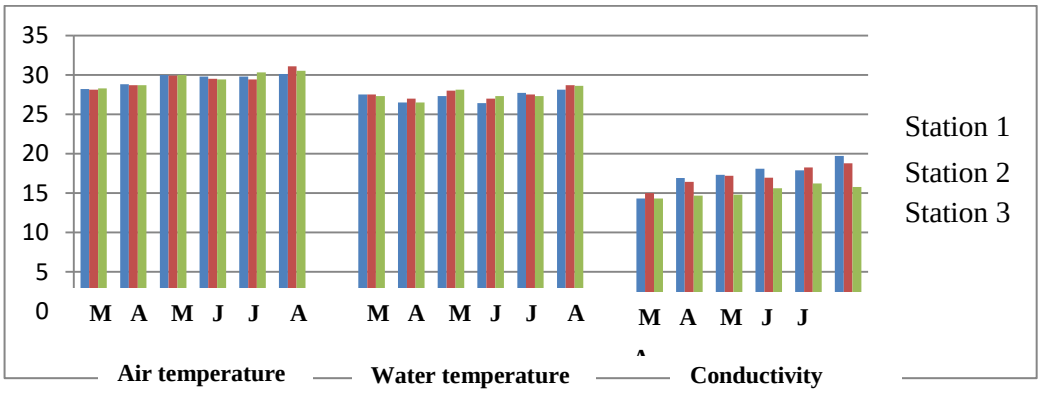

Figure 3.1 *showing the monthly variations in air and water temperature and conductivity of River Illah from March to August, 2016.*

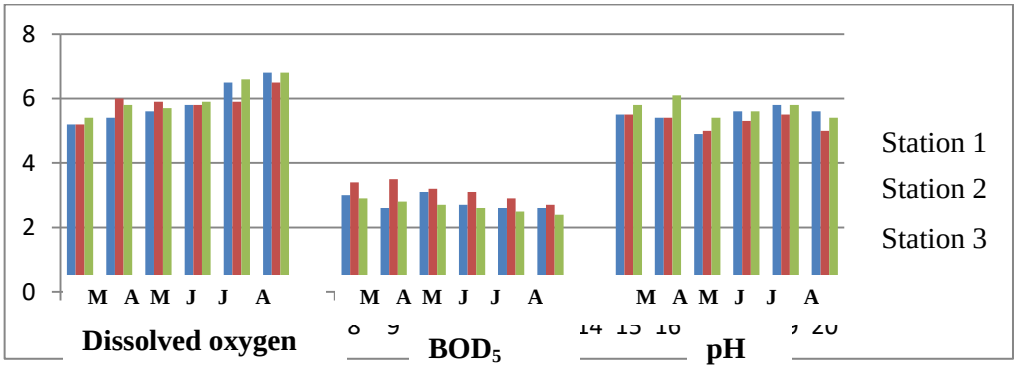

Figure 3.2 *showing the monthly variations in Dissolved oxygen, Biological oxygen demand and hydrogen concentration of River Illah from March to August, 2016.*

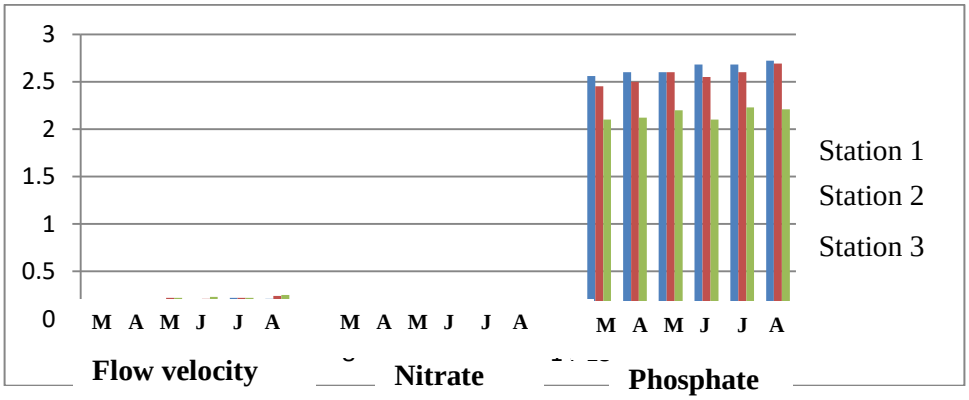

Figure 3.3 *showing the monthly variations in Flow velocity, Nitrates and Phosphate of River Illah from March to August, 2016.*

Table 3.6 *Macro invertebrate diversity indices within sampled stations of River Illah from March to August, 2016.*

	Station 1	Station 2	Station 3
Total number of individuals	116	234	161
Total number of species	6	19	10
Species richness (Margalef's index)	1.05	3.29	1.77
Shannon-Wiener index (H)	1.73	2.74	2.41
Evenness index (Pielou's index J)	0.96	0.93	1.00
Simpson's dominance index (C)	0.25	0.07	0.13

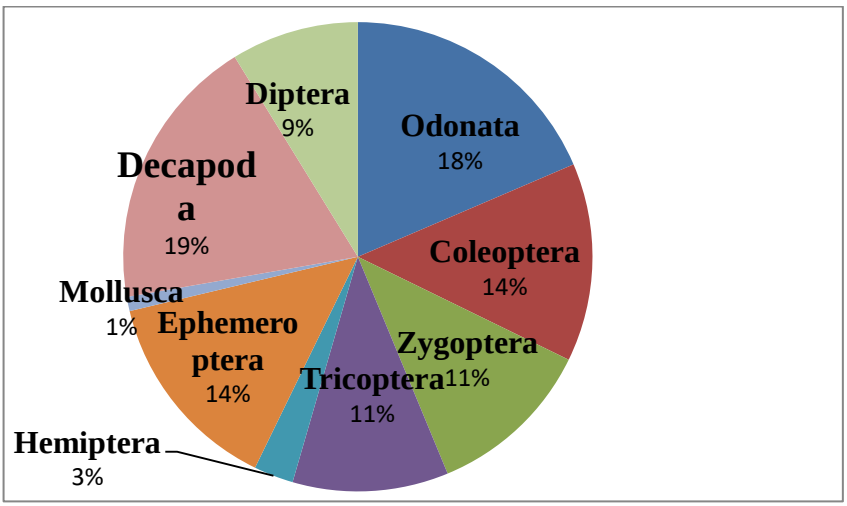

Figure 3.4 *showing the percentage density of macro invertebrate of River Illah from March to August, 2016.*

4. Discussion

The World Health Organization (1998) have set a standard for water quality in any water body. The Water quality of Illah was within agreeable limits to the WHO standards. The pH was slightly acidic as compared to those reported by Yisa and Jimoh (2010). They noted that drops of external materials from the water shed into the water body can influence the water pH thus affecting the water quality and extent of pollution. Nitrates in this study is below the limits of those reported to cause methaemoglobinaemia in infants within the age of 6 months or even lesser and eutrophication of water (World Health Organization, 1998; Egereonu and Nwachukwu, 2005).Phosphates at the three sites were also within tolerable levels as those reported by World Health Organisation. The average values dissolved oxygen and biological oxygen demand from all the three sampled sites reveals that the water body is extremely oxygenated and to that effect displaying that influences from gully run-offs and deposition of human waste materials to increase microbial activities that would reduce the DO are at minimal (Patnaik, 2005). The low recorded density of macro invertebrates in this study may be ascribedto the negative correlation effect of vital physiochemical parameters on the density of macro benthos. Although, Nwadiaro (1984) had observed that distribution of mollusk in the lower region of Niger Delta was accounted to neutrality or slightly alkalinity brackish water zone, this study recorded a slight acidic water that account to the low (0.98%) molluskdensity encountered and due spearman correlation showed no negative effect with selected parameters (table 4.4);the fact that mollusk inhabits waters which are either slightly alkaline or in its neutrality reveals that they might still inhabit waters that are slightly acidic in nature but with a reduced density as recorded in this research. This study holds maximum potential and not significantly different from researches carried out on other tributaries ofNiger Delta Rivers. Arimoro 2011 had reported 13 morphological distinct taxa belonging to six families from a stream in the Niger Delta. Also, George (2009)reported 19 species of benthic macro invertebrate fauna belonging to four phyla, six classes and 12 families at Okpoka Creek. In 2006, Arimoro and Osakwe identified 434 individuals by kick sampling method representing 21 taxa of benthic macro invertebrates at Benin River Niger Delta. Similarly, Hart and Zabbey (2005) recorded 30 taxa belonging to 20 families and 5 classes of macro invertebrates in Woji creek in the upper reach of Bonny River in the lower Niger Delta. This study obtained 26 taxa belonging to 23 families, 3 classes and 9 orders of macro invertebrates and the low sampled benthic invertebrate fauna may be due to no increased sampling efforts. River characteristics such as high flow velocity encouraging dissolved oxygen, shallow depth, and stony bed are important to encourage higher taxa richness and abundance than other water bodies with fine sediment (Yung-Chul et al., 2016). Hence critically acting as factors to the distribution and macro benthic diversity. This was the case for this study as the spatial density diversity of macro invertebrates might have been due also to the vegetative coverage from the river tract and channeling or the repeated allochtonous materials from the surrounding vegetative coverage as reported by Yisa and Jimoh (2010). Pollution tolerant species were lacking in the control station (1), prominent in station 2 where repeated dense anthropogenic activities were dominant – *Chironomus transvaalensis* and slightly represented in station 3 Mollusc (Sphaeriidae); some species reoccurring in station 3 might have been washed from station 2 by water currents. Macro benthic species in water bodies have a way of adapting to physicochemical and biological conditions as variations in physicochemical determinants will result in spatial macro benthic species sampled (Idowu and Ugwumba, 2005; Sharma et al., 2013).High current observed in station 1 (control station) might have resulted in the high DO recorded, few samples collected and the paramount cause of macro invertebrates dislodged into station 2 and 3 and the resultant low density diversity in station 1 respectively. Presence of high dense pollution tolerant and intolerant species is attributed to the eutrophic nature of the water body and pollution in tolerant species dislodged from station 1. Since River Illah were mainly dominated by pollution intolerant species at each stations, the waters of the River is thereby considered unpolluted and of good quality.

5. Conclusion

The macro benthic invertebrate diversity of River Illah is quiet low and it presentsrecorded list of specieswhich would adding to the knowledge of the density diversity and abundance of species at large. Devised efforts should be geared toward a more effective sampling model to enhance accuracy of samples and determination of water quality for suitability.

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References

[1] APHA (American Public Health Association) “Standard methods for the examination of water and waste water” in APHA ed. Washington, D.C1985.

[2] Arimoro F.O., Iwegbu C.M.A., and Enemudo B.O. “Effect of cassava effluent on benthic Macro invertebrates assemblages in a tropical stream in Southern Nigeria”,Acta Zoologica Lituanica 18(2) Pp 147-156. 2008.

[3] Arimoro, F.O and Muller, W.J “Mayfly (Insect: Ephemeroptera) community structure as an indicator of the ecological status of a stream in the Niger Delta area of Nigeria,”Environmental monitoring and assessment 166, Pp 1-4.2010.

[4] Arimoro, F.O. and Osakwe, E.I. “The influence of sawmill wood waste on the distribution and population of macro invertebrates at Benin River, Niger Delta”. Chemistry and Biodiversity 3(5), Pp 578-592. 2006.

[5] Cranston P.S. “Electronic guide to the Chironomidae of Australia” http://www.entomologiucdavis.edu/chiropage 24/11/2012.2000

[6] Egborge A.B.M., Ezemonye L.I. and Ayoze G. "Macro invertebrate fauna of Udu-ughievwen Wetland, Southern Nigeria",Journal of Aquatic Science 18(1), Pp 1-8.2003.

[7] Ezekiel E.N., Hart A.I. and Abowei J.F.N."Benthic Macro invertebrate fauna composition and abundance in Sombreiro River", Niger Delta. Research Journal of Applied Science, Engineering and Technology 3(4), Pp 256-263. 2011.

[8] George A.D.I., Abowei J.F.N. and Alfred-Ockiya J.F."The distribution, abundance and seasonality of benthic macro invertebrate in Okpoka Creek Sediment, Niger Delta, Nigeria",Research Journal of Applied Science, Engineering and Technology 2(1), Pp 11-18. 2010.

[9] George A.D.I., Abowei J.F.N. and Daka E.R. (2009): Benthic macro invertebrate fauna and physicochemical parameters in Okpoka Creek Sediment Niger Delta, Nigeria. International Journal of Animal and Veterinary Advances 1(2): 59-65

[10] Gerber A. and Gabriel M.J.M."Aquatic invertebrates of South Africa Rivers Field guide," Institute for water quality studies 1&11, Pp 34-150. 2002.

[11] Hart A.I. and Zabbey N."Influences of some physic0chemical parameters on the composition and distribution of benthic fauna in Woji Creek Niger Delta, Nigeria",Global Journal of Pure and Applied Science 12 (1), Pp1-5. 2006.

[12] Idowu EO and Ugwumba AAA "Physical, chemical and benthic fauna characteristics of a southern Nigerian reservoir",The Zool3, Pp 15 - 25.2005.

[13] Ikomi R.B., Arimoro F.O. and Odihirin O.K. "Composition, distribution and abundance of macro invertebrates of the Upper reaches of River Ethiope, Delta State, Nigeria",The Zoologist 3, Pp 68-81.2005.

[14] Imoobe T.O.T. and Oboh I.P. "Physical and chemical hydrology of River Jamieson, Niger Delta, Nigeria,"Benin Science Digest 1,Pp 105-119.2003.

[15] Ludwig J.A. and Reynolds J.F. "Statistical ecology. A primer on methods and computing",Pp 337: New York, Wiley.1988.

[16] Mafuyai H.B., Wade J.W., Agrom A.K. and Audu B.S"Aquatic insect composition at a Simulium breeding site on River Assop, Plateau State, Nigeria", Journal of Aquatic Science 19(1), Pp 5-15. 2004.

[17] Margalef R "Diversity and stability: A practical proposal and a model of interdependence", Brookhaven Symposium on Biology, 22, Pp 25 -37. 1967.

[18] Merritt R.W. and Cummins K.W."An introduction to aquatic insects of North America," 3rd edition. Dubuque: Kendall-Hunt, IOWA. 1996.

[19] Nwadiaro, C.S., "The longitudinal distribution of macroinvertebrates and fish in a lower Niger Delta River Sombreiro in Nigeria," Hydrobiological Bulletin, 182, Pp 133-140. 1984.

[20] Ogbeibu A.E. and Oribhabor B.J. "Ecological impact of River impoundment using benthic macro invertebrates as indicator." Water research 36, Pp 2427-2436. 2002.

[21] Shannon C E and Weaver W "The mathematical theory of communication," The University of Illinois Press, Urbana, Pp. 37 – 42. 1949.

[22] Sharma S, Sudha D, Rajendra C and Vibha D "Macro-invertebrate community diversity in relation to water quality status of Kunda river (M.P.), India", Discovery3(9),Pp 40-46.2013.

[23] Walsh C., Gooderham J.P.R., Grace M.R., Sdraulig S., Rosyidi M.I. and Lelono A. "The relative influence of diffuse and point source disturbance on a small upland stream in East Java Indonesia: A preliminary investigation",Hydrobiologia 487, Pp 183-192.2002.

[24] Yisa, J. and T. Jimoh, "Analytical studies on water quality index of River Landzu,"American Journal of Applied Sciences 7 (4), Pp 453-458. 2010.

[25] Yung-Chul J., Nan-Young, K., Sang-Hun K., Young-Seuk P., Dong-Soo K. and Soon-Jin, H. "Spatial Distribution of Benthic Macroinvertebrate Assemblages in Relation to Environmental Variables in Korean Nationwide Streams,"Water 8 (27), Pp 2-20. 2016.