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Application of Diversity Indices in the Study Zooplankton Community of Taylor Creek in the Niger Delta, Nigeria

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Abstract

This study assessed the zooplankton community of Taylor creek. Zooplankton community was studied from Polaku to Agbia covering 12 sampling locations between November 2013 and July 2014. The zooplankton was enumerated and identified following standard protocol. A total of 73 species belonging to 14 taxonomic groups including Rotifera (23 species), protozoan (17 species), insecta (10 species), Nematoda (8 species), Annelida (5 species), Chordata (2 species), Crustacean, Cladocera, Gastropoda, Copepoda, Chaetognatha, Cnideria, Porifera and Bryozoa (with 1 species each). The distribution in the study based on number of species were Annelida (38%), protozoan (22%), Nematoda (18 %), insecta (10%), Rotifera (5%), Bryozoa (3%), Cladocera and Porifera (2% each). The diversity indices provided useful information about the status of the creek in terms of species richness and evenness. Specifically, the Shannon-Wiener index revealed that the creek is moderately polluted. Based on the findings of this study there is the need to minimize anthropogenic activities that alters the water quality of the creek.

Keywords: Aquatic environment; Diversity indices; Pollution; Zooplankton community.

1. Introduction

The Niger Delta ecosystems play essential role for the sustenance of the different habitats and life forms in the region [1-5]. The notable habitat of the area includes freshwater swamp forest, lowland rainforest, mangrove forest etc. The area also has several surface water bodies including marine, brackish water and fresh water [6]. The freshwater exists in different forms in the area including ponds, lakes, streams, rivers, creeks, creeklets, rivulets. The major surface water in the region is River Forcados, Orashi River and Nun River. Each of these rivers has several tributaries which empties into the Gulf of Guinea through the estuaries.

The aquatic ecosystem in the Niger Delta is habitat of several fish species, plankton (zooplankton and phytoplankton) and benthic fauna. Zooplankton are animal like plankton that are very sensitive to the environment. As such, they are used to monitor the health condition in aquatic ecosystem. Diversity index is usually used to show the diversity of a sample or community by a single number [7]. The species diversity is grouped into two viz: the number of species and distribution of individuals among species [7]. Species richness are commonly used to show the total number of species i.e richness and the species abundance (thus individuals, biomass) are used to show the distribution among the species i.e evenness [8]. But diversity indices use species richness and evenness to generate a single data, and as such provide information about the organisms under study. In a related study, [7] reported that Shannon Weiner Diversity Index provide information about the richness and proportion of each species, Evenness provide information about relative number of individuals in the sample and Dominance shows the fraction of common species.

Taylor creek is a lotic, non-tidal fresh water resource [9]. It is located in Biseni Clan and stretches into Gbarian clan in Yenagoa local government area of Bayelsa State [9]. Several studies have been carried out in Taylor creek, but most of the work focused on water quality [10], phytoplankton studies [9, 11]. But in-depth studies on the zooplankton community of Taylor creek appear scanty in literature. Due to the role of zooplankton in assessing pollution in aquatic ecosystem, this study therefore aimed at assessing the zooplankton community of Taylor creek in the Niger Delta, Nigeria using diversity indices.

2. Materials and Methods

2.1. Study Area

Taylor Creek is one of the tributaries of Orashi River which empties into the River Nun in the Niger Delta region of Nigeria. This study was carried out between Polaku and Agbia community in Yenagoa Local Government Area of Bayelsa State, Nigeria. Several human activities are carried out in the creek including boating, fishing and artisanal dredging. The water also receives several municipal wastes directly (dumping of wastes into the surface

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water) and indirectly (dumping of the wastes close to the water which end up in the surface water through runoff). In the study area, sampling was carried out in 12 locations viz: A (Izewaribi), B (Oku-oba), C (Amase-pou), D (Imbiyai-oba), E (Kala-oba), F (Obunagha), G (Opu-oba), H (Pini-oba), I (Court Kiri), J (Ogboloma), K [Etelebou (Kemie)] and L (Unka). Two distinct seasons occurs in the area i.e wet season (April to October) and dry season (November to march of the following year). The climate is characterized by relative humidity of 50- 95% and temperature of 29±8ºC all year round.

2.2. Sampling

Zooplankton were sampled by filtering 50litres of the river water through plankton net. The concentrated Zooplankton samples were put in vials and preserved wit 4% formalin before transferring to the laboratory in a cool box [12]. In the laboratory, the concentrated samples were diluted with distilled water until a 50ml concentration was achieved and the samples were homogenized by shaking.

2.3. Counting and Identification

The zooplankton samples were allowed to settle by gravity for 24 hours before decanting carefully the supernatant [13] to achieve 50 ml volume. From the stock sample, 1 ml sub-sample was taken with the help of a Pasteur pipette and transferred into a Sedgwick Rafter counting chamber. Once the slide is filled, let settle for approximately 5-10 minutes to allow the plankton to settle into a single layer. A DC2 camera (Lieder Model; MC 332) was attached to a computer and used for the identification processes. Identification guides of Patterson and Hedly [14], USEPA [15]; Cleveland, *et al.* [16]; Jeje and Fernando [17]; Emi and Caitlin [18] were used for plankton identification.

2.4. Statistical Analysis

The diversity obtained was analysed using Paleontological statistics software package by Hammer, *et al.* [19]. Microsoft excel was used to plot the charts. The Renkonen's Number was calculated based on the method described by Ogbeibu [8].

3. Results and Discussion

In this study, 73 zooplankton species belonging to 14 taxonomic groups were recorded from Taylor Creek between November 2013 and July 2014. The 14 taxonomic groups were Rotifera (23 species), protozoan (17 species), insecta (10 species), Nematoda (8 species), Annelida (5 species), Chordata (2 species), Crustacean, Cladocera, Gastropoda, Copepoda, Chaetognatha, Cnideria, Porifera and Bryozoa (with 1 species each) (Figure 1) (Table 1). The distribution in the study based on number of species were Rotifera (5%), protozoan (22%), insecta (10%), Nematoda (18 %), Annelida (38%), Bryozoa (3%), Cladocera and Porifera (2% each) (Figure 2). The populations density for each of the distinct taxa across the various locations were 113 (Annelida), 106 (Nematoda), 82 (protozoan), 37 (Rotifera), 30 (Gastropoda), 28 (insecta), 17 (Porifera), 4 (Cnideria), 3 (chordata and Chaetognatha), 2 (bryozoan) and 1 (Copepoda, Crustacean and Cladocera) (Figure 3). The population density of the zooplankton during the study period were in the order location G > B > J >A >H >I > D > E > K > C > L > F (Figure 4)

Figure-1. Mean of taxonomic group-based zooplankton population density at the sampling locations in Taylor creek between November 2013 and July 2014

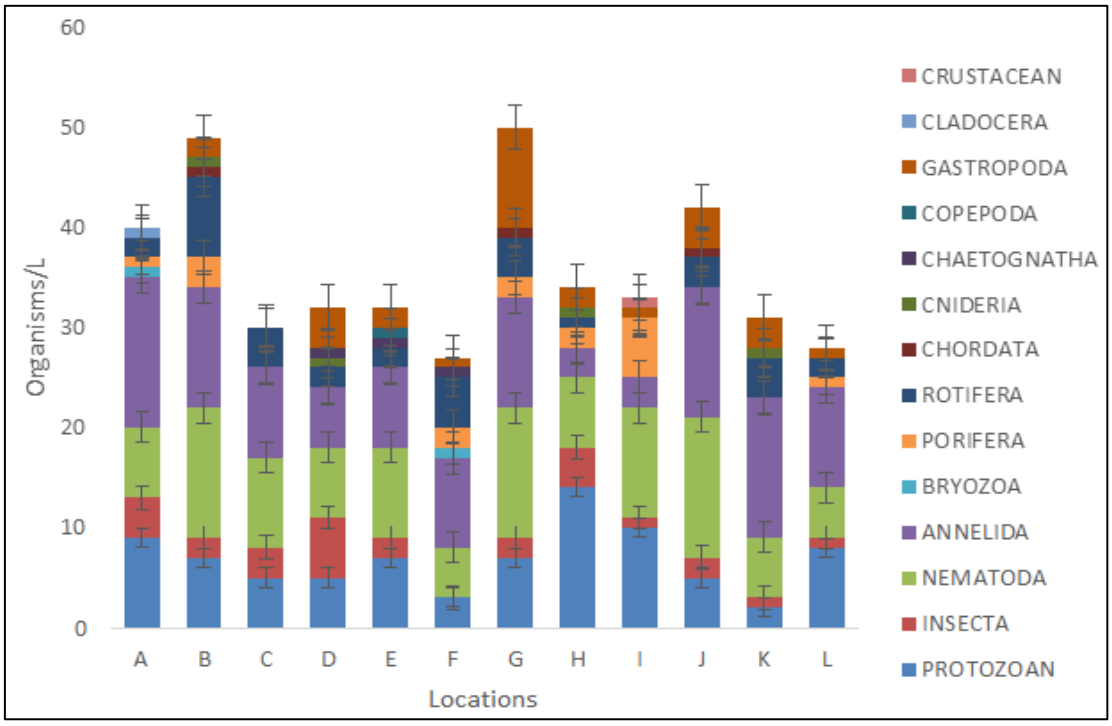

Figure-2. Distribution occurrence of each taxonomic group of zooplankton based on species in the study area between November 2013 and July 2014

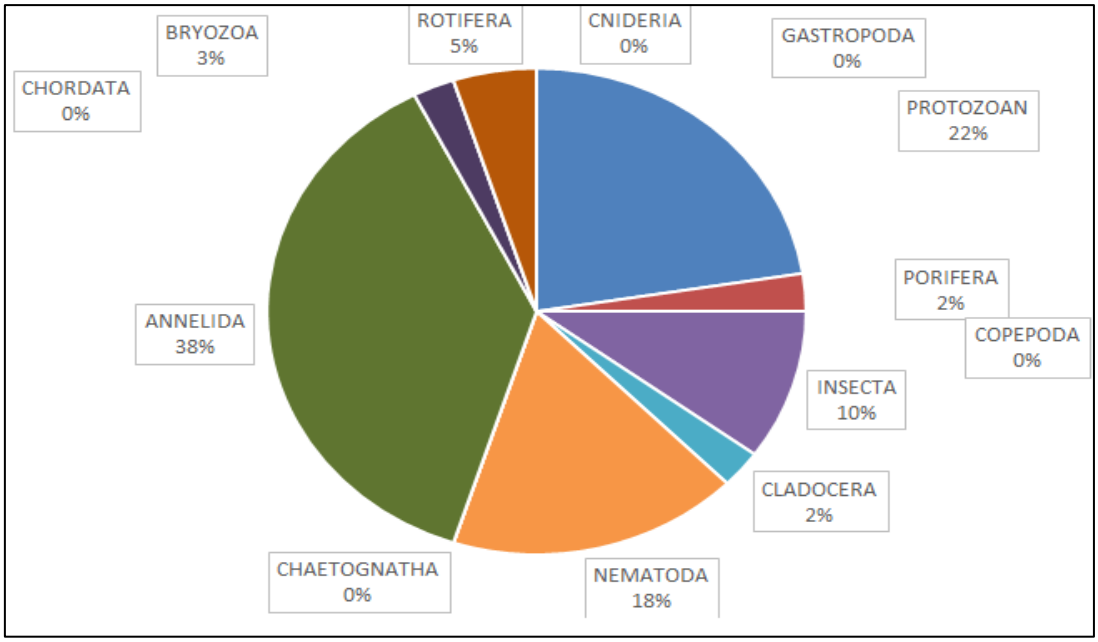

Figure-3. Populations density of the zooplankton for each of the distinct taxa across the various locations in the study area between November 2013 and July 2014

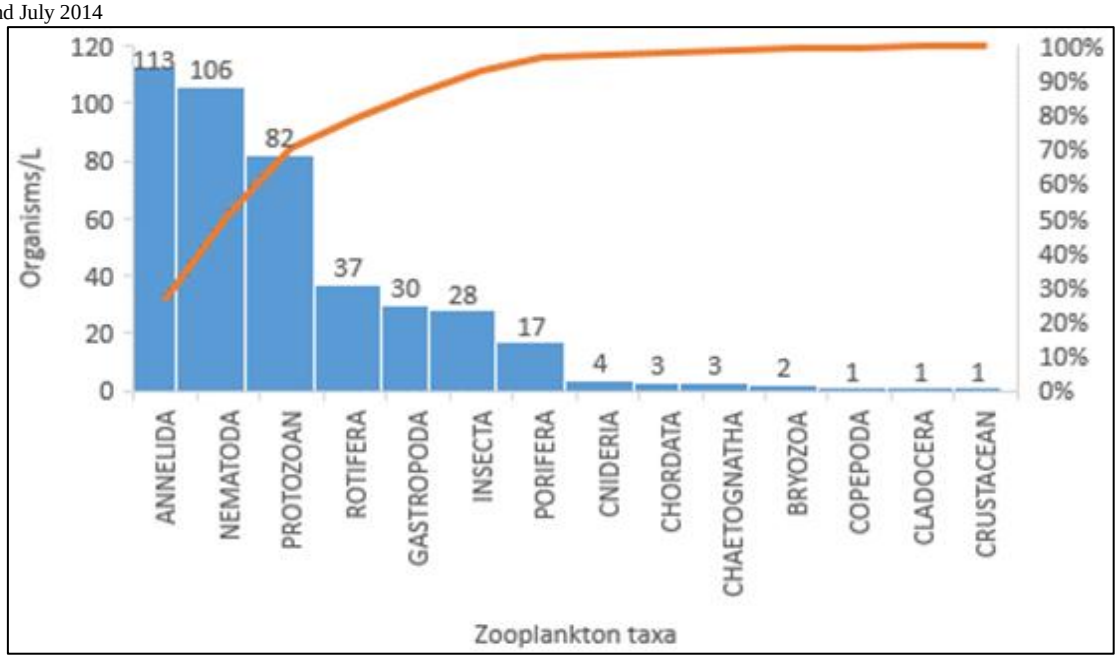

Figure-4. Population density of the zooplankton based on locations during the study period (November 2013 to July 2014)

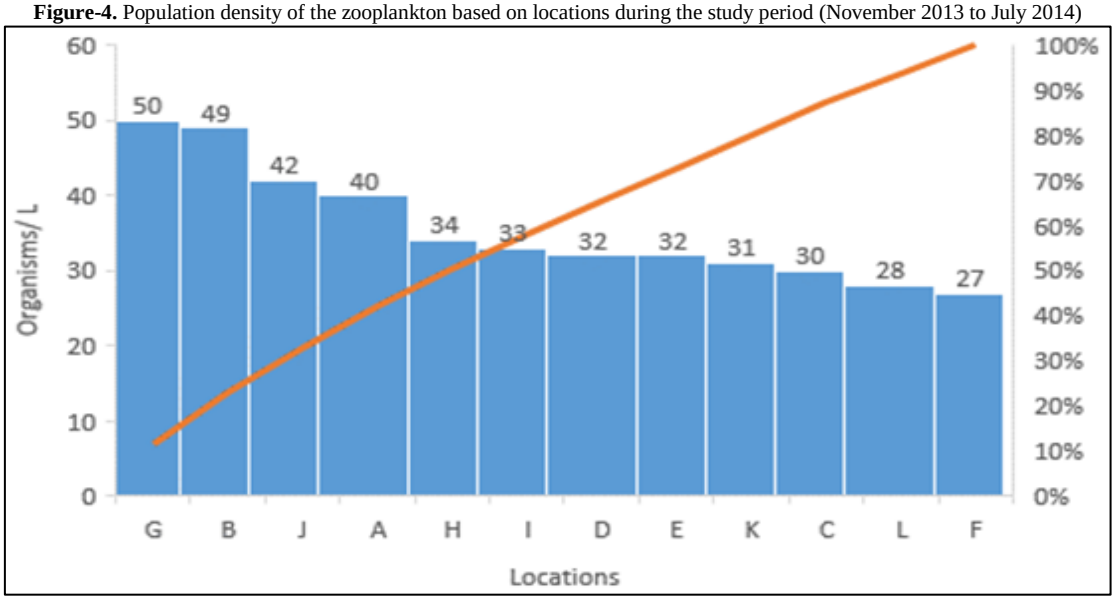

Table 1 presents the overall distribution of the zooplankton community in the study area using diversity indices. The number of species in each location were 19, 25, 17, 18, 17, 15, 21, 18, 15, 17, 15 and 15 for location A, B, C, D, E, F, G, H, I, J, K and L, respectively. Based on the diversity indices, the highest (occurring in location B) and lowest value (occurring in location K) were 0.061 and 0.205, respectively (Dominance), 0.939 and 0.795, respectively (Simpson index), 3.029 and 2.163, respectively (Shannon wiener index), 3.571 and 2.611, respectively (Menhinick), 6.167 and 4.004, respectively (Margalef index). The spatial difference in dominance values suggests that few species dominated the zooplankton community of the creek. The Shannon weiner index suggest moderate pollution in most of the locations. Simpson index in this study suggests mature and stable community, and lower value is an indication of stress effects [11]. Evenness was highest in location H and lower in location A with a value of 0.864 and 0.576, respectively. These values suggest the effect of anthropogenic activities. Margalef index provide species richness across the various locations in the study area. The Menhinick index made effort to estimate the species richness but was constrained by the sample size [11, 20], The equitability values were higher in location H (0.949) and lower in location K (0.799). Equitability index values range from 0 and 1, and a value close to 1 suggest low diversity. Hossain, *et al.* [7]; Ogamba, *et al.* [11] opined that equitability index of 1 indicates that all groups have same frequency. The equitability index provides useful information about the variability of species in the various locations.

The differences in the diversity indices in the various study areas is an indication of alteration in the water quality probably due to anthropogenic activities. Some notable parameters that could influence zooplankton community due to pollution/ nutrient level include phosphate, Sulphate and Nitrite. Shannon wiener, Margalef and Menhinick indices values in this study suggest pollution of the aquatic ecosystem. Table 2 presents the renkonen's Number for Zooplankton Community of Taylor creek, Niger Delta, Nigeria. Renkonen's number between Locations indicates significant difference at critical level of 50% in Locations G & D, J & D, J & G, K & J and L & A. This suggest variation in anthropogenic activities affecting the zooplankton community of the study area.

Table-1. Zooplankton population density and diversity indices of the zooplankton community of Taylor creek, Niger Delta, Nigeria

S/N	TAXON	Location											
		A	B	C	D	E	F	G	H	I	J	K	L
	PROTOZOAN												
1	*Paranema sp*	0	0	0	0	0	0	0	0	1	0	0	1
2	*Bodo sp*	0	0	0	0	0	1	0	0	0	0	0	0
3	*Amoeba sp*	6	0	3	2	2	0	1	2	3	2	0	1
4	*Paramecium sp*	1	3	2	1	0	0	1	1	0	0	1	0
5	*Centropyxis aculeate*	1	0	0	0	0	0	0	0	0	0	0	0
6	*Tintinnids sp*	1	0	0	1	1	0	1	1	0	1	1	0
7	*Ophrydium sp*	0	1	0	1	1	2	0	1	0	0	0	0
8	*Harpacticoida sp*	0	0	0	0	2	0	0	0	0	0	0	1
9	*Stentor polymorphus*	0	2	0	0	0	0	1	0	0	0	0	0
10	*Litonomus sp*	0	0	0	0	0	0	0	4	0	0	0	1
11	*Litonotus fasciola*	0	0	0	0	0	0	1	5	2	0	0	0
12	*Chitomonas sp*	0	0	0	0	0	0	0	0	2	0	0	0
13	*Euglena sp*	0	0	0	0	1	0	0	0	2	0	0	0
14	*Litonotus fasciola*	0	0	0	0	0	0	0	0	0	1	0	0
15	*Epistylis sp*	0	0	0	0	0	0	0	0	0	1	0	1
16	*Litostomatea*	0	0	0	0	0	0	2	0	0	0	0	3
17	*Cothurnia anulata*	0	1	0	0	0	0	0	0	0	0	0	0
	Subtotal	**9**	**7**	**5**	**5**	**7**	**3**	**7**	**14**	**10**	**5**	**2**	**8**
	INSECTA												
18	*Garris (water strider)*	1	1	1	2	0	0	0	0	0	0	0	0
19	*Acarus siro*	0	0	1	0	1	0	0	2	0	2	0	0
20	*Chaoborus sp*	1	0	0	2	1	0	2	0	0	0	0	0
21	*Chauliodes sp*	1	0	0	0	0	0	0	0	0	0	0	0
22	*culex sp (egg)*	0	1	0	1	0	0	0	0	1	0	0	1
23	*Hydrophilidae sp*	0	0	1	0	0	0	0	0	0	0	0	0
24	*Larva of hydroptilidae*	1	0	0	0	0	0	0	0	0	0	0	0
25	*Psephenus sp*	0	0	0	1	0	0	0	0	0	0	0	0
26	*Tabanus sp*	0	0	0	0	0	0	0	2	0	0	0	0
27	*Trichoptera sp*	0	0	0	0	0	0	0	0	0	0	1	0
	Subtotal	4	2	3	6	2	0	2	4	1	2	1	1
	NEMATODA												
28	*Bunonema sp*	2	0	0	4	0	0	4	0	2	6	0	1
29	*Dolichodorus sp*	0	1	0	0	0	0	0	0	1	1	2	0
30	*Helicotylenchus sp*	2	2	1	1	6	2	2	1	0	0	0	3
31	*Hemicycliophora sp*	1	2	1	0	0	0	1	2	4	2	1	0
32	*Microlaimus sp*	0	3	1	0	0	0	1	1	2	0	1	0
33	*Oncholaimus sp*	0	0	0	1	0	0	0	0	0	0	0	0

34	*Plectus sp*	0	3	1	0	1	0	0	0	0	0	0	0
35	*Triplva sp*	2	2	5	1	2	3	5	3	2	5	2	1
	Subtotal	7	13	9	7	9	5	13	7	11	14	6	5
	ANNELIDA												
36	*Dero sp*	0	1	2	0	0	0	0	0	0	1	1	0
37	*Earthworm*	0	1	0	0	0	0	0	0	0	0	0	0
38	*Hirudinea sp*	1	2	1	0	2	1	3	2	0	1	0	0
39	*Stylaria sp*	0	0	0	0	0	1	0	0	0	0	0	0
40	*Tubifex sp*	14	8	6	6	6	7	8	1	3	11	13	10
	Subtotal	15	12	9	6	8	9	11	3	3	13	14	10
	BRYOZOA												
41	*Bryozoan larva*	1	0	0	0	0	1	0	0	0	0	0	0
	Subtotal	1	0	0	0	0	1	0	0	0	0	0	0
	PORIFERA												
42	*Sponges sp*	1	3	0	0	0	2	2	2	6	0	0	1
	Subtotal	1	3	0	0	0	2	2	2	6	0	0	1
	ROTIFERA												
43	*Anuraeopsis fissa*	0	0	0	0	1	0	0	0	0	0	0	0
44	*Aspelta aper*	0	0	0	0	0	0	0	0	0	1	0	0
45	*Brachirous forfibala*	0	0	0	0	0	0	1	0	0	0	0	0
46	*Branchionus rubens*	1	0	0	0	0	0	0	0	0	0	0	0
47	*Collotheca metabilis*	0	1	1	0	0	0	0	0	0	0	0	0
48	*Collotheca ornata*	0	0	1	0	0	0	1	0	0	0	0	0
49	*Conochilus hippocrepsis*	0	1	0	0	0	0	0	0	0	0	0	0
50	*Dicranophorus caudatus*	0	0	0	0	0	0	0	0	0	1	0	0
51	*Floscularia sp*	0	0	0	0	0	0	0	0	0	0	1	0
52	*Keratella cochlearis*	0	2	1	1	0	2	1	0	0	0	1	0
53	*Lacane stichaea*	0	0	1	0	0	0	0	0	0	0	0	0
54	*Lacinularia flosculosa*	0	0	0	0	1	0	0	0	0	0	0	0
55	*Lepedella aspida*	1	0	0	0	0	0	0	0	0	0	0	0
56	*Lepedella ovalis*	0	0	0	0	0	0	0	0	0	0	0	1
57	*Limnias sp*	0	0	0	0	0	1	0	0	0	0	0	0
58	*Macrochaetus sericus*	0	0	0	0	0	0	0	1	0	0	0	0
59	*Macrochaetus subquadratus*	0	2	0	0	0	0	0	0	0	0	0	0
60	*Microcodides chlaena*	0	0	0	0	0	1	0	0	0	0	0	0
61	*Nothalca acuminate*	0	0	0	1	0	1	0	0	0	0	1	1
62	*Rotaria neptunia*	0	2	0	0	0	0	0	0	0	0	0	0
63	*Rotifera sp*	0	0	0	0	0	0	0	0	0	0	1	0
64	*Trichocerea sp*	0	0	0	0	0	0	0	0	0	1	0	0
65	*Wolga spinifera*	0	0	0	0	0	0	1	0	0	0	0	0
	Subtotal	2	8	4	2	2	5	4	1	0	3	4	2
	CHORDATA												
66	*Fish larva*	0	1	0	0	0	0	1	0	0	0	0	0
67	*Appendicularia sp*	0	0	0	0	0	0	0	0	0	1	0	0
	Subtotal	0	1	0	0	0	0	1	0	0	1	0	0
	CNIDERIA												
68	*Hydra sp*	0	1	0	1	0	0	0	1	0	0	1	0
	Subtotal	0	1	0	1	0	0	0	1	0	0	1	0
	CHAETOGNATHA												
69	*Chaetognath sp*	0	0	0	1	1	1	0	0	0	0	0	0
	Subtotal	0	0	0	1	1	1	0	0	0	0	0	0
	COPEPODA												
70	*Copepod sp*	0	0	0	0	1	0	0	0	0	0	0	0
	Subtotal	0	0	0	0	1	0	0	0	0	0	0	0
	GASTROPODA												
71	*Pteropoda sp*	0	2	0	4	2	1	10	2	1	4	3	1
	Subtotal	0	2	0	4	2	1	10	2	1	4	3	1
	CLADOCERA												
72	*Daphnia sp*	1	0	0	0	0	0	0	0	0	0	0	0
	Subtotal	1	0	0	0	0	0	0	0	0	0	0	0
	CRUSTACEAN												
73	Spironloxarus	0	0	0	0	0	0	0	0	1	0	0	0

	marine												
	Subtotal	0	0	0	0	0	0	0	0	1	0	0	0
	Taxa_S	19	25	17	18	17	15	21	18	15	17	15	15
	Dominance	0.161	0.061	0.100	0.090	0.100	0.114	0.097	0.074	0.091	0.125	0.205	0.166
	Simpson Index	0.839	0.939	0.900	0.910	0.900	0.886	0.903	0.926	0.909	0.875	0.795	0.834
	Shannon Weiner	2.392	3.029	2.572	2.653	2.577	2.464	2.670	2.744	2.551	2.431	2.163	2.274
	Evenness	0.576	0.827	0.770	0.789	0.774	0.783	0.688	0.864	0.855	0.669	0.580	0.648
	Menhinick index	3.004	3.571	3.104	3.182	3.005	2.887	2.970	3.087	2.611	2.623	2.694	2.835
	Margalef index	4.880	6.167	4.704	4.905	4.617	4.248	5.112	4.821	4.004	4.281	4.077	4.201
	Equitability index	0.813	0.941	0.908	0.918	0.910	0.910	0.877	0.949	0.942	0.858	0.799	0.840

Table-2. Renkonen's Number for Zooplankton Community of Taylor creek, Nigeria

ZOOPLANKTON	A	B	C	D	E	F	G	H	I	J	K	L
A	100	36.03	48.3	46.3	42.6	43.4	63.5	29.1	33.2	48.3	47.5	53.3*
B		100	53.02	40.96	33.7	36.34	48.24	37.8	36.56	34.96	43.4	33.24
C			100	37.7	41.1	41	35.6	36.1	30.9	48.2	42.5	30.5
D				100	15.6	41.1	54.7*	32.1	30.6	56*	47.1	45.1
E					100	46.1	45.7	38.4	27.6	37.7	34.5	43.9
F						100	43.4	30.7	25.6	43.1	42.5	47.7
G							100	42.2	36.3	51.6*	42.2	36.4
H								100	38.4	34.3	30	23.8
I									100	36.3	27.6	29.5
J										100	52.7*	43
K											100	46.4
L												100

*Critical Level = 50%, i.e. (≥ 50% = similar, ≤ 50% = dissimilar).

4. Conclusion

This study assessed the zooplankton community of Taylor creek, Niger Delta, Nigeria. The taxonomic zooplankton community of creek were Rotifera, protozoan, insect, Nematoda, Annelida, Chordata, Crustacean, Cladocera, Gastropoda, Copepoda, Chaetognatha, Cnideria, Porifera and Bryozoa. The diversity indices provided useful information about the quality of the aquatic ecosystem, richness of species and evenness. The Shannon Wiener index showed that the creek is moderately polluted.

References

[1] Izah, S. C., 2018. "Ecosystem of the Niger Delta region of Nigeria: Potentials and Threats." *Biodiversity International Journal*, vol. 2, p. 338–345.

[2] Izah, S. C., Aigberua, A. O., and Nduka, J. O., 2018. "Factors affecting the population trend of biodiversity in the Niger Delta region of Nigeria." *International Journal of Avian and Wildlife Biology*, vol. 3, p. 206–214.

[3] Izah, S. C., Angaye, C. N., Aigberua, A. O., and Nduka, J. O., 2017. "Uncontrolled bush burning in the Niger Delta region of Nigeria: potential causes and impacts on biodiversity." *International Journal of Molecular Ecology and Conservation*, vol. 7, pp. 1-15.

[4] Izah, S. C. and Seiyaboh, E., 2018. "Challenges of wildlife with therapeutic properties in Nigeria; a conservation perspective." *International Journal of Avian & Wildlife Biology*, vol. 3, p. 259–264.

[5] Izah, S. C. and Seiyaboh, E. I., 2018. "Changes in the protected areas of Bayelsa state, Nigeria." *International Journal of Molecular Evolution and Biodiversity*, vol. 8, pp. 1-11.

[6] Agedah, E. C., Ineyougha, E. R., Izah, S. C., and Orutugu, L. A., 2015. "Enumeration of total heterotrophic bacteria and some physico-chemical characteristics of surface water used for drinking sources in Wilberforce Island, Nigeria." *Journal of Environmental Treatment Techniques*, vol. 3, pp. 28-34.

[7] Hossain, M. R. A., Pramanik, M. M. H., and Hasan, M. M., 2017. "Diversity indices of plankton communities in the River Meghna of Bangladesh." *International Journal of Fisheries and Aquatic Studies*, vol. 5, pp. 330-334.

[8] Ogbeibu, A. E., 2005. *Biostatistics. A practical approach to research and data handling*. Benin-City Nigeria: Mindex Publishing Company Limited.

[9] Alagoa, K. J., 2015. "Assessment of Creek integrity using Phytoplankton in Taylor Creek, Biseni, Bayelsa State, Nigeria." *Int. J. Curr. Microbiol. App. Sci.*, vol. 4, pp. 942-952.

[10] Daka, E. R., Amakiri-Whyte, B., and Inyang, I. R., 2014. "Surface and groundwater quality in some oil field communities in the niger delta: Implications for domestic use and building construction." *Research Journal of Environmental and Earth Sciences,* vol. 6, pp. 78-84.

[11] Ogamba, E. N., Charles, E. E., and Izah, S. C., 2019. "Phytoplankton community of taylor creek in the niger delta using diversity indices." *Journal of Plant and Animal Ecology,* vol. 1, pp. 1-12.

[12] American Public Health Association APHA, 1998. *Standard Method for examination of water and waste water*. 20th edition ed. New York: American Public Health Association.

[13] Robert, J. L., Akshithala, K. P., Xufeng, N., and Sean, E. M., 2012. "Effect of ammonia in pulp mill effluents on estuarine phytoplankton assemblages: Field descriptive and experimental results." *Aquatic Botany,* vol. 74, pp. 343-367.

[14] Patterson, D. J. and Hedly, S., 1992. *Free-living freshwater protozoan*. Wolf, England: A colour Guide. p. 223.

[15] United State Environmental Protection Agency, 2009. *Great lake water life photo gallery. Sea great extension office, sea grant lake network*. Great Lakes Environmental Research Lab.

[16] Cleveland, P., Hickman, J., Larry, Roberts, S., Allan, Helen, L., I'anson, and David, J. E., 2006. *Integrated principle of zoology*. 13th edition ed. McGraw-Hill Companies.

[17] Jeje, C. Y. and Fernando, C. H., 1986. *A practical guide to the identification of nigerian zooplankton (cladocera, copepoda and rotifera)*. Nigeria: Kainji Lake Research Institute. p. 142.

[18] Emi, Y. and Caitlin, B., 2007. "Zooplankton identification guide." Available: http://www.marex.uga.edu/aquarium

[19] Hammer, Ø., Harper, D. A. T., and Ryan, P. D., 2001. "PAST: Paleontological statistics software package for education and data analysis." *Palaeontologia Electronica,* vol. 4, p. 9.

[20] Shah, J. A. and Pandit, A. K., 2013. "Application of diversity indices to crustacean community of Wular Lake, Kashmir Himalaya." *International Journal of Biodiversity and Conservation,* vol. 5, pp. 311-316.