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Distribution and Abundance of Zooplankton in Anthropogenic-Impacted Stream, Nsit-Ibom, Nigeria

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ABSTRACT: This study aimed to investigate the distribution and abundance of zooplankton in Mbiokporo stream Nsit-Ibom Local Government Area, Akwa Ibom State, Nigeria. Samples were collected and analyzed using standard methods. The result revealed that there were 9 zooplankton taxonomic groups (namely: *Arachnida, Bdelloidae, Branchiopoda, Chromadorae, Euglenoidea, Hexanauplia, Insecta, Polychaeta, Tubulinea*), comprising 12 species and 91 individuals. The most abundant zooplankton species was *Temora longicornis* with the highest number of species across all the stations 24 > 19 > 7 for station 1, station 2, and station 3 respectively. *Branchiopoda* had the highest number of species (4) and highest species composition (33.33%), while *Hexanauplia* recorded the highest individual abundance (54.95%). The relative abundance of zooplankton phyla was as follows: (*Hexanauplia*, 54.95 %) > (*Branchiopoda*, 13.19 %) > (*Bdelloidae*, 8.79) % > (*Chromadorae*, 7.69 %) > (*Polychaeta* and *Arachnida*, 5.49 % each) > (*Insecta*, 2.20 %) > (*Tubulinea*, 1.10 %) respectively. Indices of species dominance were as follows: station 1 > station 2 > station 3, with the following values 0.4349 > 0.4235 > 0.2397 each. Meanwhile, the highest species evenness was in station 3 (0.7887), followed by station 2 (0.5495), while the lowest was in station 1 (0.486). Margalef's species diversity was slightly higher in station 1 (1.649) than in station 3 (1.618) while the lowest was in station 2 (1.456). The equitability index among stations was as follows: 3 (0.8675) > station 2 (0.6659) > station 1 (0.6292). However, this result revealed that ongoing anthropogenic activities along the stream may resulted in the deterioration of the stream thereby leading low species composition of zooplankton as observed in this study.

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Zooplankton are microscopic animals that drift with water currents. Since they do not possess real power to move against real the water current. They are referred to as "drifters" or "floaters" (Dimowo, 2013). They constitute the most vital components of the aquatic ecosystem and play a significant role in the energy transfer between phytoplankton and fishes in the aquatic environment (Harris and Vanobaba, 2012). Zooplankton function as intermediaries between fish and lower trophic levels therefore serving as food for juvenile and adult fish. They perform a critical role in the aquatic food web as many of them feed largely on algae and bacteria and in turn, they are being fed by invertebrates and fish predators (Ogbeibu, 2001). This role and their high sensitivity to changes in environmental factors have made environmental scientists and hydrobiologists focus on zooplankton occurrence, composition, distribution, and their significant role in pollution studies (Ogbeibu and Obanor, 2002). Zooplankton play an important role in

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the eutrophic structure of a river, as consumers of phytoplankton and act as a source of food for both shell and fin-fishes (Ayodele and Adeniyi 2006; Ikhuoriah *et al*. 2015). Zooplankton, which composed all a mixed group of tiny, living animals that float, drift freely, or feebly swim in water columns independent of the shore and bottom (Sommer 1994), occupy the base level of food chains that are consumed by commercially important fisheries have severally been used as bio-indicators of water quality (Keller *et al*. 2008). Therefore, they are recognized as pollution indicator organisms in the aquatic environment globally (Rutherford *et al*. 1999; Yakubu *et al*. 2000; and Ikhuoriah *et al*. 2015). Zooplanktons are important aquatic organisms that occur in all aquatic habitats (Siddique and Kale, 2018), and can be classified as phytoplanktivores and zooplanktivores, depending on their feeding habits which in turn make up an essential foods organism to other aquatic macro invertebrates in the higher trophic levels (Erondu and Solomon, 2017). The disparity in the species composition and abundance of Zooplankton within a particular water body indicates changes in physicochemical parameters and unfavourable anthropogenic activities (Sunder, 2015; Azuka *et al.,* 2018). Understanding the composition and abundance of zooplankton is crucial in the determination of water quality and the productivity of the aquatic ecosystem. Zooplankton are ideal organisms for theoretical and experimental population ecology due to their small sizes, short generation time, and relatively homogenous habit (Ekpo, 2013). Despite the numerous studies of planktons (Phytoplankton and zooplankton) in Akwa Ibom state, water bodies, information on zooplankton abundance and distribution in Mbiokporo stream is currently lacking despite the significant role of the stream to Mbiokporo community and its ecological relevance. Therefore, the objective of this paper is to evaluate the distribution and abundance of zooplankton in Mbiokporo Stream, Nsit-Ibom Local Government Akwa Ibom State, Nigeria

MATERIALS AND METHODS

Mbiokporo Stream is located in Nsit-Ibom Local Government, Akwa Ibom State, Nigeria. The stream lies between latitude 4º57’45’’ N, and longitude 7º52’11’’ E. The Mbiokporo community depends on this stream for their drinking water supply.

Field Sampling: Sampling stations were chosen along the stretch of the stream based on related human activities in the stream. The three sampling stations selected were as follows: Station 1 was located on (Latitude 4º58’30’N, and 7º52’11’’ E), station 2 was located on (Latitude 4º58’21’’N, and 7º52’15’’E), and station 3 was located on (Latitude 4º57’50’’N, and7º52’12’’E). The vegetation cover at the bank of the stream included guinea grass (*Panicum maximum*), raffia palm (*Raphia hookeri*), and gigantic grass (*Bamboo sp*). Samples were collected between 7:00 am and 9:00 am from January to March (dry season) and from August to October (wet season), 2021.

Zooplankton collection and preservation: A standard plankton net of 55µm mesh was used to collect zooplankton samples. The procedure was done according to the method described by (Ekpo *et al.*, 2020). Briefly, the zooplankton net was swept horizontally along each sampling station for about 3 minutes just below the surface water during sampling. The samples were stored in one-liter bottles and fixed with 10% formalin immediately after collection to preserve the organisms from deterioration, and labeled appropriately according to sampling station. They were immediately transported to the Fisheries Laboratory in the Department of Fisheries and Aquatic Environmental Management, University of Uyo, Uyo, for analyses.

Laboratory Procedures: After the initial settling of the preserved sample in the laboratory, about three-quarters of the water sample was decanted into a beaker to concentrate the zooplankton specimens at the bottom of the bottle. The remaining one-quarter of the decanted water sample was poured in batches into a petri dish just to cover the bottom of the petri dish. The petri dish with the subsample was mounted under the Leitz Wetzler binocular microscope using the scanning, low, and high power objectives at 100-400x magnifications (Ekpo *et al.,* 2020).

Zooplankton identification and enumeration: The composite zooplankton species were identified with the aid of zooplankton identification guides, descriptions, and illustrations such as (Newell and Newell 1977; APHA-AWWA-WPCF 2005; Ricci and Melone 2000). Zooplankton identified were grouped according to their taxa and species.

Data Analysis: The species dominance (D), species evenness e^H/S, Margalef’s index (d), and equitability (J) were calculated using the method described by (Ogbeibu, 2005). Percentage composition and graphical illustration were done using Microsoft Excel (version 2016).

RESULTS AND DISCUSSION

Distribution and abundance of zooplankton: The results of the distribution and abundance of zooplankton studied in the Mbiokporo stream are presented in Table 1. A total of 9 taxa, 12 species, and 91 individuals were encountered throughout the study period in all the stations. Station 1 had the highest number of species (7) and also the highest number of individual populations (38) while stations 2 and 3 had the same number of species (6) with different numbers of individuals (31) and (22). *Temora longicornis* had the highest number of species across all the stations 24 > 19 > 7 for station 1, station 2, and station 3 respectively.

Table 1: Zooplankton abundance and diversity in the Mbiokporo stream

Taxonomic Group	Station 1	Station 2	Station 3	Total
Arachnida				
Pholcus phalangioides	3	2	0	5
subtotal	3	2	0	5
Bdelloidae				
Philodina acuticornis	6	2	0	8
subtotal	6	2	0	8
Branchiopoda				
Bosmina coregoni	0	1	6	7
Daphnia magna	1	0	2	3
Moina brachiata	0	0	1	1
Bosmina affinis	0	0	1	1
subtotal	1	1	10	12
Chromadorae				
Angiostrongylus cantonensis	1	6	0	7
subtotal	1	6	0	7
Euglenoidea				
Euglena sanguinea	1	0	0	1
subtotal	1	0	0	1
Hexanauplia				
Temora longicornis	24	19	7	50
subtotal	24	19	7	50
Insecta				
Lacane luna	2	0	0	2
subtotal	2	0	0	2
Polychaeta				
Polychaete larvae	0	0	5	5
subtotal	0	0	5	5
Tubulinea				
Amoeba radiosa	0	1	0	1
subtotal	0	1	0	1
Total	38	31	22	91

Zooplankton composition: The result of the composition of zooplankton is presented in Table 2. Branchiopoda had the highest (4) number of species and highest (33.33%) species composition while Hexanauplia recorded the highest (54.95%) individual abundance and highest (50) number of individuals. Other classes had (1) species and (8.33%) composition each. A higher number of individuals was recorded in station 1 followed by stations 2 and 3 respectively. The relative abundance of zooplankton phyla was as follows: Hexanauplia 54.95 % > Branchiopoda 13.19 % > Bdelloidae 8.79 % > Chromadorae 7.69 % > Polychaeta and Arachnida 5.49 % each > Insecta 2.20 % > Tubulinea 1.10 % respectively.

Zooplankton Diversity: The results of the diversity indices of zooplankton in the Mbiokporo stream are presented in Table 3. The trend of each diversity index was as follows. Species dominance D had the following trend: station 1 > station 2 > station 3. With the following values 0.4349 > 0.4235 > 0.2397 each. Meanwhile, the highest species evenness was in station 3 (0.7887), followed by station 2 (0.5495), while the lowest was in station 1 (0.486). Margalef's species diversity was slightly higher in station 1 (1.649) than in station 3 (1.618) while the lowest was in station 2 (1.456). Equitability was station 3 (0.8675) > station 2 (0.6659) > station 1 (0.6292).

Table 2: Abundance and species composition of zooplankton.

Taxa	Total number of individuals	Relative abundance	Total number of species	Species abundance %
Arachnida	5	5.49	1	8.33
Bdelloidae	8	8.79	1	8.33
Branchiopoda	12	13.19	4	33.33
Chromadorae	7	7.69	1	8.33
Euglenoidea	1	1.10	1	8.33
Hexanauplia	50	54.95	1	8.33
Insecta	2	2.20	1	8.33
Polychaeta	5	5.49	1	8.33
Tubulinea	1	1.10	1	8.33
Total	91	100	12	100

Table 3: Diversity indices

Indices	Station 1	Station 2	Station 3
Number of species per station	7	6	6
Total number of Individuals	38	31	22
Dominance_D	0.4349	0.4235	0.2397
Species Evenness_e^H/S	0.486	0.5495	0.7887
Margalef species diversity	1.649	1.456	1.618
Equitability_J	0.6292	0.6659	0.8675

Generally, tropical waters usually have a low composition and diversity of zooplankton. This has been reported many in research studies carried out in most tropical water by different authors: Akin-Oriola 2003, Ogbeibu *et al*. 2001, Imoobe and Adeyinka 2009. This also goes in line with the report of this study Table 1. In previous studies, the authors reported that zooplankton assemblage of typical tropical water bodies and noted that their structure can provide critical information on nutrient and pollution statuses of their water bodies. Interestingly, micro-communities in freshwater bodies constitute a major diverse assemblage of organisms and are represented by most of the invertebrate phyla, however, the dominant zooplankton in most water bodies includes rotifers, *cladocerans, copepods,* and *ostracods*

(Kennie *et al.* 2017*)*. The composition and diversity of zooplankton communities in most tropical aquatic ecosystems are strongly influenced by several factors such as physicochemical characteristics of the water, predation, quality of edible algae, and competition (Hellawell 1986; Ovie and Adeniji 1994). The presence of zooplankton species depends on environmental tolerance and the resources available (Ikomi and Anyanwu, 2010) Reduction in competition or predation and increased food supply or suitable habitat increased, enhanced zooplankton abundance (Obot *et al*. 2020).

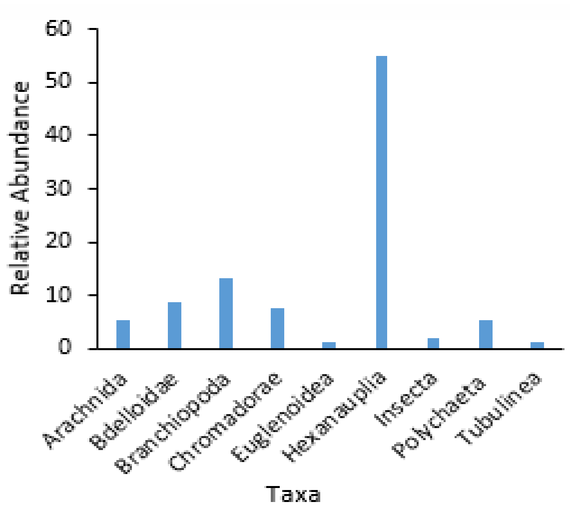

Fig 1. Relative abundant of zooplankton taxa

In this study, twelve species of zooplankton belonging to nine taxonomic groups were identified this was similar to the report of Ekpo *et al.*, (2014). In their studies, on Species Composition and Abundance of Zooplankton in a Freshwater Ecotone in Akwa Ibom State, Southeastern Nigeria, they reported a similar trend of zooplankton. Dimowo (2013), in Ogun River, also reported a similar trend of zooplankton composition. However, there were differences in the low species composition obtained in this study with findings from many authors. Ezekiel *et al*. (2011) reported seventeen zooplankton species belonging to six taxonomic groups in the Sombreiro River. Ekpo (2013), reported 4 classes, 41 genera, 53 species, and 1681 cells/l of zooplankton in Ikpa River, Obot *et al.* (2020) revealed a total of 9 species belonging to 6 taxonomic groups in Stubbs Creek. Imoobe and Adeyinka (2009), observed that the most dominant zooplankton species in West African freshwater ecosystems, include *Keratella tropica, Keratella quadrata, Brachionus angularis, Trichocerca pusilla, Filinia longiseta*, *Pompholyx sulcata*, *Proales* sp., and others that are indicator species of high trophic levels which play a significant role in energy transfer and ecosystem engineering.

The most abundant zooplankton species in this study was *Temora longicornis* (Hexanauplia) recorded across all the sampling stations. Ekpo, (2013) recorded a dissimilar result. In her study, *anthocamptus staphylinus* (Copepoda) was the dominant species in station 1, *Asplanchna priodonta* (Rotifera) in station 2, and *Bosmina longicorns* (Cladocera) in station 3. The regularly most dominant species in West African lotic systems according to (Imoobe and Adeyinka 2010), were lacking in this study. In contrast to the observed trend in the present study in which *Temora longicornis*, was the most dominant species recorded in station 1, station 2, and station 3. Furthermore, Okorafor *et al*, (2013) reported Calanoida as the most dominant zooplankton order in their study this was against Hexanauplia reported in this study. However, the number of species observed in this study is still lower than that reported by (Dimowo, 2013), (Ugouru and Audu, 2012) who both reported 16 and 17 species of zooplankton, respectively. These differences in the abundance and number of zooplankton species observed between this study and the other studies reported could be due to the difference in study area, study duration, study period, water quality, presence of pollution, and level of human activities in the different studies. Interestingly, the nature of species occurring, diversity, biomass, and season of maximum abundance of zooplankton organisms differ in water bodies (FAO, 2006, James *et al*, 2008). Differences in the intensity of environmental disturbances such as water current, turbidity, temperature, and dissolved oxygen variations could induce changes in the structure and function of biological systems (Odiete, 1999). The relationships between fluctuations in plankton communities and water environmental factors significantly affect the distribution and abundance of zooplankton communities in the different study areas (Onyema, 2007). Herein, there was a variation in zooplankton distribution across different sampling stations, and these variations could be due to pollution, and levels of human activities such as washing, bathing, and sand mining measured at different sampling stations. In terms of the composition of zooplankton taxa, Branchiopoda had the highest (4) number of species and highest (33.33%) species composition while Hexanauplia recorded the highest (54.95%) individual abundance and highest (50) number of individuals. Other classes had equal number (1) species and species composition (8.33%) each. Variation in the number of individual species across stations revealed that station 1 had the highest number of species (7) while stations 2 and 3 had (6) species each. The relative abundance of zooplankton phyla was as follows: Hexanauplia 54.95 % > Branchiopoda 13.19 % > Bdelloidae 8.79 % > Chromadorae 7.69 % > Polychaeta and Arachnida 5.49 % each > Insecta 2.20 % > Tubulinea 1.10 % respectively (Fig. 1). This finding was not in agreement with other studies where authors found zooplankton taxa as the dominant taxon Egborge (1981); Jeje and Fernando (1986); Copepods were the most abundant zooplankton taxon constituting more than half (54.89%) of the zooplankton abundance in the Calabar River (Uttah *et al*. 2008). Also, Barnes *et al.* (1988) observed that copepods dominate most aquatic ecosystems because of their resilience and adaptability to changing environmental conditions and ability to withstand varying environmental stresses. The taxon Branchiopoda had the highest number of species (4) while others had (1) species each Table 2. This was not in consonant with (Ekpo *et al.*, 2014) who reported rotifer as the most abundant group of zooplankton in their study.

The diversity indices values: Dominance, evenness index, Margalef's index, and equitability showed poorly/low zooplankton diversified. The low zooplankton species diversity may be attributed to high environmental disturbance and pollution. Although, the zooplankton community showed poor diversity, zooplankton species that make up were evenly distributed. This finding agrees with the finding of Ajuomu *et al.*, (2011) who reported a poor diversity of Zooplankton in the Bonny estuary.

Conclusion: Zooplankton play critical role in aquatic ecosystem engineering. Herein, the most abundant taxa in terms of number of individuals were Branchiopoda with four species namely (*Bosmina coregoni, Daphnia magna, Moina brachiate, and Bosmina affinis*). Other taxon had one species each. The low abundance and diversity of zooplankton in the Mbiokporo stream may be due to anthropogenic activity, environmental disturbance and pollution. There is a need to regulate the amount of sewage discharge into the stream to prevent total ecological collapse, extinction of fauna and flora, and adverse impact on human health.

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