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Spatial distribution and abundance of zooplankton communities in Lake Victoria, Kenya

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Abstract
The study was conducted between January and March 2015 in the Kenyan waters of Lake Victoria. Duplicate composite vertical samples of zooplankton were collected from the water column using 50µm plankton net of 30 cm diameter and preserved with 5% formalin prior to identification in the laboratory. Water quality parameters were also measured *in-situ*. Cyclopoid copepods (64.7%) dominated the zooplankton community while Rotifers (1.7%) were the least abundant in the lake. A total of 20 zooplankton species were identified under the taxa 9 Rotifer, 6 Cladoceran, 4 Cyclopoid and 1 Calanoid. Multiple comparisons by Tukey test showed no significant difference in zooplankton density among the stations (p>0.05). The highest values of water quality parameters recorded were turbidity 70.52 mgL^{-1}, conductivity 158.72 µS/cm, temperature 27.38ºC, Dissolved Oxygen 5.25 mgL^{-1} and pH 8.06, with corresponding lowest values of 11.09 mgL^{-1}, 93.26 µS/cm, 25.74ºC, 4.35 mgL^{-1} and 7.41. The observations from the study could be linked to the habitat degradation and pollution causing changes in the zooplankton community in Lake Victoria.

Keywords: zooplankton, pollution, Lake Victoria

1. Introduction
Zooplanktons are small animals that float, drift, or weakly swim in the water column and have very limited power of locomotion [1]. Freshwater zooplankton is an important component in aquatic ecosystems as they act as primary and secondary links in the food chain [2]. They form a food resource base for most juveniles as most fish feed on zooplankton before undergoing ontogenic shift later in their life. This has been documented by many researchers studying the feeding behavior of different fish species in Lake Victoria and other lakes [3, 4, 5]. Zooplankton abundance and distribution patterns and diversity within aquatic ecosystems is affected by a plethora of factors. These factors can be biotic or abiotic in nature. Among the biotic factors could be predation by fish or by other aquatic organisms including by other zooplankton as well as changes in the phytoplankton communities within the lake environment [6]. Abiotic factors on the other hand are mainly due to physico-chemical parameter within the lake [7, 8]. The present study therefore, investigated the spatial distribution and abundance of zooplankton communities within Lake Victoria as an important aspect for ecosystem management.

2. Materials & methods
Zooplankton samples were collected for three months between January and March 2015 in the Kenyan waters of Lake Victoria. Sampling stations were at Dunga (0˚08'40.7"S, 34˚44'12.4"E); Ngegu (0˚29'25.0"S, 34˚30'03.8"E), and Wichlum (0˚14'21.4"S, 34˚12'34.3"E) (Fig.1). Dunga is shallow (3-4 m) covering the inner Nyanza gulf waters. Ngegu is deep (8-14 m) and covers the mid Nyanza gulf waters. Wichlum is shallow (5-7 m) covering the open waters.

1.1 Sampling and Analysis of samples
Duplicate composite vertical samples of zooplankton were collected from the water column using 50µm plankton net of 30 cm diameter and preserved in 500 ml vials with 5% formalin. In the laboratory, the samples were washed with water to remove the formalin, and then diluted to 100mls of which 10mls were sub-sampled for identification and counting using an inverted microscope at x 100 magnification. The zooplanktons species were identified using keys by Jung (2004) [9]. The abundance of zooplankton was expressed as follows: Individual/m^3 = (Number/Area of net mouth opening /Depth of sampling site). Water quality parametres including Dissolved Oxygen (DO), conductivity, pH, temperature and turbidity were also measured *in-situ*. One-Way ANOVA (with Tukey test for multiple comparisons) was used for the test of spatial variation of zooplankton abundance and water quality parameters.

3. Results
3.1 Physico-chemical parameters
The mean (±SD) values of the physico-chemical parameters are presented in Table 1 below. The highest (5.25±0.49 mgL^{-1}) and lowest (4.35±0.71 mgL^{-1}) values of Dissolved Oxygen were recorded at Wichlum and Dunga respectively. Multiple comparisons using Tukey test showed that DO differed within the stations (F =5.23, p<0.05). Dunga (158.72±3.16 µS/cm) recorded the highest and Wichlum (93.26±0.49 µS/cm) the lowest conductivity. The results showed a significant difference in conductivity values (F=1607.38, p<0.05). Dunga (27.38±0.82 ºC) and Wichlum (25.74±0.30 ºC) recorded the highest and the lowest temperatures respectively. There was no significant difference in the temperature values (F=3.42, p>0.05). The highest pH (8.06±0.38) was recorded at Wichlum and the lowest (7.41±0.24) at Dunga. Tukey test showed that pH values were significantly different (F=10.98, p<0.05). Dunga (70.52±6.93 mgL^{-1}) and Ngegu (11.09±2.83 mgL^{-1}) recorded the highest and the lowest turbidity values

respectively. Turbidity values also differed significantly (F=323.97, p<0.05).

3.2 Zooplankton community

Cyclopoid copepods (64.7%) dominated the zooplankton community while rotifers (1.7%) were the least abundant (Fig. 1). A total of 20 zooplankton species were identified (Table 2). Nine species were Rotifers, with *Brachionus angularis* Gosse 1851 as the most abundant. There were 6 taxa of Cladocerans, with *Diaphanosoma excisum* Sars 1885 and *Daphnia lumhortzi* Sars 1885 as the most abundant. There were 4 Cyclopoid taxa with *Thermocylops decipiens* Kiefer 1929 and *Tropocylops confinis* Kiefer 1929 as the most abundant. There was only one Calanoid taxon, *Thermodiaptomus galeboides* Sars 1901. Dunga recorded the highest abundance of Cladocera (4.5%) and Rotifera (3.3%). However, cyclopoida (67.9%) and Calanoida (34.1%) were most abundant at Wichlum and Ngegu respectively. The highest density of zooplankton (15680 m^{-3}) was recorded at Dunga and the least (7823 m^{-3}) at Wichlum. Multiple comparisons by Tukey test showed no significant difference in zooplankton density among the stations (F=1.00, p>0.05).

Table 1: Summary of physico-chemical parameters (Mean±SD).

Station	DO (mgL^{-1})	Conductivity (µS/cm)	Temperature (ºC)	pH	Turbidity (mgL^{-1})
Dunga	4.35±0.71	158.72±3.16	27.38±0.82	7.41±0.24	70.52±6.93
Ngegu	4.45±0.53	135.41±2.11	27.29±2.10	7.68±0.20	11.09±2.83
Wichlum	5.255±0.49	93.26±0.49	25.74±0.30	8.06±0.38	16.67±5.65

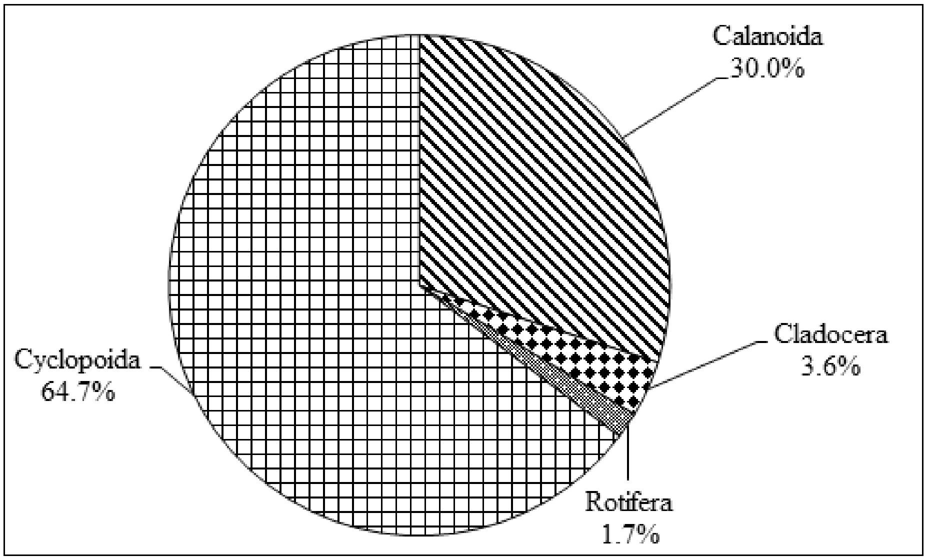

Fig 1: Percentage composition of zooplankton taxa in the Kenyan waters of Lake Victoria

Table 2: Abundance (individual/m^3) of zooplankton species from the studied stations

Stations	Dunga		Wichlum		Ngegu	
Taxa	Ind/m^3	%	Ind/m^3	%	Ind/m^3	%
Cladocera		4.5		4.1		2.3
Diaphanosoma excisum	172	1.1	120	1.5	84	0.9
Moina micrura	149	1.0	93	1.2	51	0.5
Ceriodaphnia cornuta	23	0.1	0	0.0	4	0.0
Bosmina longirostris	82	0.5	41	0.5	63	0.6
Daphnia barbata	45	0.3	7	0.1	0	0.0
Daphnia lumhortzi	233	1.5	61	0.8	27	0.3
Calanoida		28.5		27.3		34.1
Calanoid copepodite	2538	16.2	1062	13.6	1790	18.3
Thermodiaptomus galeboides	1926	12.3	1075	13.7	1552	15.8
Cyclopoida		63.7		67.9		62.5
Cyclopoid copepodite	3164	20.2	2011	25.7	2338	23.9
Eucyclops sp	386	2.5	201	2.6	186	1.9
Mesocylops sp	571	3.6	283	3.6	422	4.3
Thermocylops decipiens	3154	20.1	1493	19.1	2276	23.2
Tropocylops confinis	2719	17.3	1325	16.9	900	9.2
Rotifers		3.3		0.7		1.1
Brachionus calyciflorus	86	0.5	7	0.1	0	0.0
Brachionus angularis	245	1.6	38	0.5	79	0.8
Brachionus patulus	128	0.8	0	0.0	0	0.0

Brachionus quadridetatus	32	0.2	3	0.0	1	0.0
Keratella tropica	14	0.1	0	0.0	6	0.1
Keratella quadata	1	0.0	0	0.0	10	0.1
Polyrthra sp.	0	0.0	0	0.0	2	0.0
Filinia sp.	12	0.1	3	0.0	0	0.0
Lecane sp.	0	0.0	0	0.0	8	0.1
Total individual/m^3	15680		7823		9799	

4. Discussion
Zooplankton distribution and abundance is affected by several biotic and abiotic factors within the aquatic environment. The distribution therefore tends to differ among sites even within the same ecosystem [8,10]. These differences are attributed to patchiness in resource distribution within the lake as well as effects of other factors such as water quality parameters and predatory pressure by fish [7]. In the present study, Dunga had the highest abundance of zooplankton as compared to other stations. This could be attributed to the fact that nearshore areas have more habitat complexities offering more biotopes compared to the relatively uniform habitats in the open water areas of the lake as suggested by Ngupula *et al* (2010) [11]. Zooplankton abundance has also been seen to be enhanced by moderate pollution as recorded by Uriarte & Villate, (2004) [12] in their study on effects of pollution on zooplankton abundance and distribution in two estuaries of the Basque coast, Spain. They argue that moderate pollution encourages growth of green algae which increases food for the zooplankton in these systems.

Rotifers are known to be adaptable to poor water quality conditions as observed at Dunga, while calanoids are more successful in the open waters which are less polluted like the case of Wichlum. The nearshore areas are more prone to moderate pollution especially from urban runoff that could account for the higher turbidity and conductivity, and the lower pH values and Dissolved oxygen recorded at Dunga. Similar observations have been made by Badsi *et al* (2010) [13] in a polluted lagoon in Southern Morocco. Calanoids and cladocerans are herbivorous and could easily have be affected by the changes in the phytoplankton assemblages attributed to eutrophication and siltation due to anthropogenic activities around Lake Victoria [14]. The phytoplankton community within the lake has become dominated by cyanobacteria and microcystis which are more difficult and/or harmful to consume by the herbivorous zooplankton communities.

The results from this study have shown that the anthropogenic activities around the lake have significant effect on the zooplankton community. This can have a cascading effect up the food chain and might affect fish which depend on zooplankton as food in their formative developmental stages. There is therefore need to address eutrophication in the lake. Plankton community should be included in the lake management plans as they can be used as bio-indicators of pollution [15, 1, 12].

5. References
1. Varris JM, Vinobaba P. Impact of Water Quality on Species Composition and Seasonal Fluctuation of Planktons of Batticaloa lagoon, Sri Lanka. J Ecosy. Ecogr. 2012; 2(4):2-7.
2. Rask M, Holopainen A, Karusalmi A, Niinioja R, Heinimaa S, Karppinen C, *et al.* An introduction to the limnology of the Finnish Integrated Monitoring lakes. Limnol. 1998, 263-274.
3. Njiru M, Okeyo-Owuor JB, Muchiri M, Cowx IG. Shifts in the food of Nile tilapia, *Oreochromis niloticus* (L.) in Lake Victoria, Kenya. Afri. J Ecol. 2004; 42:163-170.
4. Katunzi EFB, Van Densen WLT, Wanik JH, Witte F. Spatial and seasonal patterns in the feeding habits of juvenile *Lates niloticus* (L.), in the Mwanza Gulf of Lake Victoria. *Hydrobiol.* 2006; 568(1):121-133.
5. Outa NO, Kitaka N, Njiru JM. Some aspects of the feeding ecology of Nile tilapia, *Oreochromis niloticus* in Lake Naivasha, Kenya. Int. J Fish. Aqu. Stud. 2014; 2(2):1-8.
6. Heneash AMM, Tadrose HRZ, Hussein MM, Hamdona SK, Abdel-aziz N, Gharib SM. Potential effects of abiotic factors on the abundance and distribution of the plankton in the Western Harbour, south-east Mediterranean Sea, Egypt. Oceano. 2015; 57(1):61-70.
7. Sousa W, Attayde JL, Rocha EDS. Eskinazi-Sant Anna EM. The response of zooplankton assemblages to variations in the water quality of four man-made lakes in semi-arid northeastern Brazil. J Plankt. Res. 2008; 30(6):699-708.
8. Omondi R, Yasindi AW, Magana A. Spatial and Temporal Variations of Zooplankton in Relation to Some Environmental Factors in Lake Baringo, Kenya. Egert. J Sci. Tech. 2011; 11:29-50.
9. Jung F. A Guide to Tropical Freshwater Zooplankton Identification, ecology and impact on fisheries. Aqu. Ecol. 2004; 38:1-432.
10. Waya RK. Zooplankton communities of selected stations of Lake Victoria. Tanz. J Sci. 2004; 30(1):11-20.
11. Ngupula GW, Waya RK, Ezekiel CN. Spatial and temporal patterns in abundance and distribution of zooplankton in the Tanzanian waters of Lake Victoria. Aqu. Ecosy. Health. Mgt. 2010; 13(4):451-457.
12. Uriarte I, Villate F. Effects of pollution on zooplankton abundance and distribution in two estuaries of the Basque coast (Bay of Biscay). Mar. Pol. Bul. 2004; 49(3):220-228.
13. Badsi H, Ali HO, Loudiki M, Hafa MEl, Chakli, Aamiri RA. Ecological factors affecting the distribution of zooplankton community in the Massa Lagoon (Southern Morocco). Afric. J Env. Sci. Tech. 2010; 4:751-762.
14. Sitoki L, Kurmayer R, Rott E. Spatial variation of phytoplankton composition, biovolume, and resulting microcystin concentrations in the Nyanza Gulf (Lake Victoria, Kenya). Hydrobiol. 2012; 691(1):109-122.
15. Ngupula GW. How Does Increased Eutrophication and Pollution in the Lake Victoria Waters Impacts Zooplankton? J Envi. Ecol. 2013; 4(2):151.