Phytoplankton distribution and abundance in small water bodies of the Lake Victoria Basin of Kenya

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Abstract
A study was conducted to assess the phytoplankton distribution and abundance in relation to physical and chemical parameters in small water bodies of the Kenyan basin of Lake Victoria during the period January to July 2014. Sampling stations were selected on a profile starting from the shallow west to the deepest part of the water body. Phytoplankton genera and species were identified using keys. Algal densities were determined by counting different types of species mounted in an uthermal chamber. Other phytoplankton parameters assessed were species diversity indices and major taxa quotients. Further the following physical chemical parameters were measured: dissolved oxygen concentration, pH, conductivity, turbidity, Seechi disc depth, temperature, hardness and alkalinity. The most abundant algal types were Chlorophyceae represented by: *Pediastrum Spp, Tetraedron sp* Cyanophyceae represented by *Microcystis spp Aphanocapsa rivularis and planktolngbya spAnabaena spp.* and Dinoflagellates represented by *Ceratinium* and *glenodininium* spp. The mean dissolved oxygen concentration ranged from 3.9 mg/l at Koziga Dam to 7.9 mg/l at Lake Kanyaboli, pH ranged from 5.9 at Korowe dam to 8.2 at Oyombe dam, The mean conductivity levels for all the dams was 142.39±63.786 µS/cm.
The results will be useful in the formulation of management advice for SWBs.

Keywords: *Phytoplankton, Diversity index, quotients, Water quality, Management.*

1. Introduction
Lake Victoria catchment area has several small lakes and dams. The satellite lakes and dams are important aquifers and buffer zones for the Lake Victoria. Besides, the water bodies are important water sources both for Livestock, domestic use and fishing. Dams and satellite Lakes are either formed naturally by rivers and underground water sources that are filled by natural depressions.

Water and aquatic resource problems are increasing in the African Great Lakes region, their ecological history problems in developed regions of the world has demonstrated the dependence of aquatic resources on wise Management of the Water shed. Lake Victoria, an important water resource shared by Tanzania Kenya, Uganda, is being threatened continuously by increasing effluents that potentially pollute the Waters. There is an urgent need to address issues concerning deterioration of water quality with the aim of conserving and protecting Lake Victoria, related Water bodies and their Catchments. This is possible through well-defined ecological and sustainable development options.

Lake Victoria and catchment rivers have received more attention in recent years, although little information is available on the phytoplankton ecology and community structure in the Satellite Lakes and dams ("Small Water Bodies'', SWB).

The monitoring of Satellite Lakes and Dams aims to ensure sustainable exploitation of water and fisheries resource by generating information on stock sizes and determine the water quality and phytoplankton species composition in the SWBs. In addition, it assess the physical and Chemical Variables under which phytoplankton in this systems are growing with a view to understanding and identifying factors that affect them and provide a baseline data on water quality and taxonomic composition of the phytoplankton communities and also formulation of management policies. Phytoplankton fluctuates with diversity and is widely used as biological determinants of water quality in lakes and dams. Water quality affects species abundance, species composition, stability, productivity, and physiological condition of indigenous populations of aquatic organisms (APHA 1985 [1].

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2. Objectives
The overall objective of the study is to assess water quality status (In situ physical-chemical parameters measurements and phytoplankton structure

2.1 Specific objective
1. To determine phytoplankton species composition, abundance and distribution in satellite lakes and dams

3. Materials and Methods
The study area constitutes the northern and southern part of lake Victoria basin. The dams have an average depth of 2.5 metres. There are 24 small water bodies sampled during January to July 2014. The main rains are from March –May with subsidiary rains in August and November. The monthly maximum air temperatures range from 27.5 ^{0}C - 31.0 ^{0}C, while the minimum ranges from 16.0 ^{0}C -18.0 ^{0}C. The dams, were, Yenga, Mauna, Mwer, Kalenjuok, Futro, Ufinya, Kanyaboli, Sare, Ochot, Korowe, Oyombe, KaTMC, Bande, Olasi, Kokech, Stella, Uriri, Kosiga, Achune, Damside, Gesibei, Kijauri, Harambee and Ahero junction.

Map 1: Study area

3.1 Sampling and laboratory analysis
Data was collected on a month of between January 2014- August 2014; sampling sites were marked using a Magellan Global Positioning System (GPS) 315 meridian. All samples were taken at a depth of 1m while *in situ* parameters were measured before sampling. Water samples were collected using Van Dorn water sampler of a capacity of 2.5 L and placed in sterile plastic sample bottles for further nutrient analysis. Phytoplankton samples were collected using phytoplankton nets, water samplers, fixed using acidic Lugol's solution and stored in plastic vials for laboratory analysis. Secchi depth was measured using a Standard Secchi disk of 20cm diameter. Turbidity was measured using a Hatch Turbidimeter 2100 p. pH was measured using a digital Mini Model 49- pH meter. Depth, temp, conductivity, chlorophyll *a* were measured using a submersible Conductivity-Temperature-Depth profiling system (CTD, Sea-bird Electronics®), programmed to take measurements at 5 seconds intervals. Alkalinity and hardness were determined using the methods highlighted in APHA (1995). Phytoplankton analyses, a 2 ml sub-sample was taken from the preserved water sample and placed in an Utermöhl sedimentation chamber and left to settle for three hours. Phytoplankton cells were identified to species level where possible and counted using an inverted microscope at 400x magnification. Ten fields of view were counted for the coccoid cyanobacteria. A 12.42 mm^2 transect was counted for the larger algae. The whole bottom area of the chamber was examined for the big and rare taxa under low (100x) magnification. Counts were taken on all individual cells, colonies or filaments. Identification was done using the methods of Huber–Pestalozzi (1968) [2] and Cocquyt *et al.* (1993).

4. Results
Twenty four small water bodies in the Lake Victoria basin in Kenya were sampled. Based on water quality parameters, there was a moderate mix of different phytoplankton taxa in the sampled sites (Fig 1 below)Diatoms were the most dominant group, contributing an average of 30% to the total phytoplankton biovolume in all satellite lakes and dams. There were fewer diatoms in (e.g. Achune 3%,Dam side 8%,Harambee 2% and Stella 6%) than in Satellite lakes Kanyaboli 4% and Sare 6% respectively and Ahero junction 77%). Except for a few other diatom species, *Aulacoseira, Diatoma,* and *Cyclotella* taxa *Nitzschia* and *Synedra* were the more abundant taxa in most of the dams. Within the Cyanobacteria, *Anabaena* spp, *Chroococcus spp and Planktolyngbya sp* were the most abundant and appeared at least all sites sample.
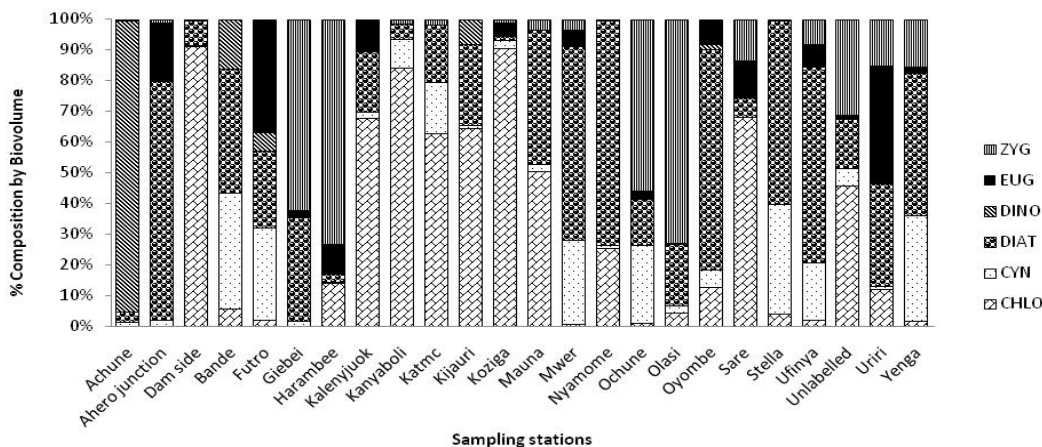
Fig 1: Phytoplankton relative % composition as recorded at different sites of the Satellite lake and Dams

Phytoplankton bio-volume showed moderately high densities in the dams, (Fig. 2). Members of the Dinoflagellates were more common in one station (Achune dam) and were represented by *Glenodinium pulvastitus and Ceratinium taxa*. The *Zygnematophyceae* family was represented by *Crucigenia taxa,Cosmarium taxa* and *Staurastrum* taxa with the former frequently observed in most of the dams except Achune dam. In striking similarity to the biovolume measurements, phytoplankton cells were more in the dams than in satellite lakes, in particular, Gesibei, ufinya and Korowe, all the sites had > 100 x 10^6 cells per litre in (Fig. 2).
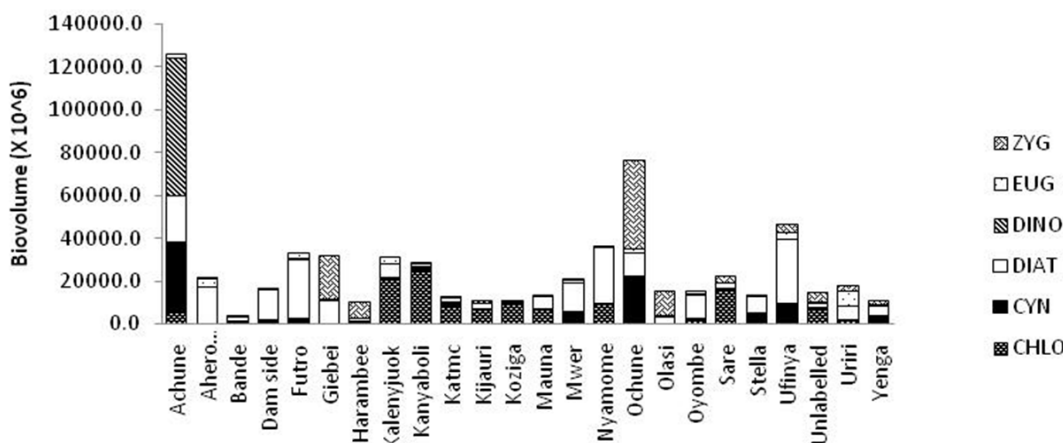

Fig 2: Phytoplankton cells per litre (cells x 10^6) as recorded at different sites of the Satellite Lake and Dams

5. Discussion

Results of this study showed temporal changes of the community. The Satellite Lakes and dams are the most significant driving forces that cause predictable variations in phytoplankton composition due to algal species occupying different ecological niches within the water hyacinth mats. Studies shows that almost in all water bodies; diatom algae were dominant by over 30 %, because of a direct result of direct supply of nutrients from agricultural lands that surround the water bodies. Livestock deposits high amounts of waste for the rapid proliferation of the phytoplankton. High amount of cynobacteria in most water bodies can produce and release sufficient toxins causing deterioration in both water quality and safety. The Main causes of pollution in the small water bodies include effluents and run-off from agricultural areas; the nutrients have stimulated massive growth of water hyacinth plants and algae. The vegetation decomposes and dissolved oxygen block light to deeper waters especially in satellite dams like Lake Kanyaboli. This, in turn, proves very harmful to aquatic organisms particularly fish as it affects the respiration ability of fish and other invertebrates that reside in

water. Hence fish in most of the water bodies have stunted growth. According to the study it is crucial to note that limnological conditions of a water body have been identified as important factors influencing the structuring of fish assemblages (Jackson D.A. & Harvey H.H. 1989, APHA 1985) [1]. Thus, physiochemical parameters such as temperature, dissolved oxygen (DO), depth and size affect the abundance, species composition, stability, productivity, and physiological condition of indigenous populations of aquatic organisms and water hyacinth mats. Thus, the nature and health of aquatic communities is an expression of the limnological status of water body. Changes in these water quality variables bring about changes in phytoplankton communities and consequently affect the quantity and quality of food items available for invertebrates as well as fish, thus, affecting fish production. Some algal species, for example, *Microcystis* are unpalatable and even toxic to fish. Phytoplankton studies, therefore, help to explain the distribution and abundance of fishes in a particular environment.

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