THE DIVERSITY OF BENTHIC MOLLUSCS OF LAKE VICTORIA AND LAKE BURIGI

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ABSTRACT

Molluscan diversity, abundance and distribution in sediments of Lake Victoria and its satellite lake, Lake Burigi, were investigated. The survey was carried out in January and February 2002 for Lake Victoria and in March and April 2002 for Lake Burigi. Ten genera were recorded from four zones of Lake Victoria while only three genera were recorded from Lake Burigi. In Lake Victoria the most diverse zone was Mara zone. The mollusca communities comprised of Bellamya, Gabbiella, Melanoides, Bulinus, Biomphalaria *and* Cleopatra *(Gastropoda) and* Corbicula, Eupera (Byssanodonta), Caelatura and Sphaerium *(Bivalvia). Lake Burigi comprised of* Melanoides, Bulinus and Biomphalaria. Melanoides tuberculata and Biomphalaria chaonomphala *were the only two gastropods represented and widely distributed in the two lakes. Bivalvia constituting of* Corbicula africana *and* Caelatura *sp. were well distributed in Lake Victoria. The density of gastropods was higher in Speke gulf (1150 ind./m^2) and Lake Burigi (1101 ind./m^2) compared to remaining sampling zones in the main Lake (449 ind./m^2; 369 ind./m^2; and 60 ind./m^2 for Mwanza Gulf, Mara zone, and Kagera zone, respectively). The influence of physical and chemical conditions determining the molluscan species abundance and distribution in the two lakes and the role of mollusca in fish production is discussed.*

INTRODUCTION

Lake Victoria basin has been a source of food protein and income since time immemorial. The main Lake (Lake Victoria) currently supports an export market of mainly *Lates niloticus* to European countries, U.S.A. and the Middle East. Recently the lake has been experiencing changes that have affected fish and virtually all-ecological components in the ecosystem (Witte et al. 1992). These changes have caused reduction or extinction of native flora and fauna (Witte et al. 1992).

The introduction of *Lates niloticus* to the lake have contributed to the reduction of indigenous fishes (Witte et al. 1992). Eutrophication arising from nutrient over-enrichment (Hecky 1993) has occurred in the lake with a doubling of nutrient concentrations and algal productivity since 1960 and a tenfold increase in algal biomass (Mugidde 1992). This has caused the de-oxygenation of much of the lake bottom threatening the survival of deep-water fish species and other organisms, and has created nutrient rich conditions in which water hyacinth (*Eichhornia crassipes*) has thrived. However, information on the changes affecting the benthic molluscs in the Tanzanian waters is at present very scanty. Most of the early studies were based on analyses of stomach contents of fishes (Corbert 1961, Greenwood 1981, Katunzi 1983, Hoogerhoud et al. 1983, Balirwa 1984, Hoogerhoud 1986, Mosille 1988) and on the taxonomy of gastropods and their medical importance (WHO 1987, Brown 1994).

This paper describes the benthic molluscan community in Lake Victoria and compares with the community of a satellite lake, Lake Burigi and summarises the influence of physical and chemical conditions determining the molluscan species abundance and distribution in the two lakes.

MATERIALS AND METHODS

Study area

The study was carried out in the Tanzanian waters of Lake Victoria snd Burigi. Mollusc samples were obtained from four major ecological zones of Lake Victoria and from Lake Burigi. The ecological zones of Lake Victoria included Mara, Speke Gulf, Mwanza Gulf and Kagera.

Sample and data collection

Sampling was carried out in January/February 2002 in Lake Victoria and in March/April 2002 in Lake Burigi. Eckman grab (384.16 cm^2 was used to collect the sediment samples. Three hauls were collected from each sampling point and treated as a composite. From each station three samples were taken. Wash bags and sieves of 400μm and 500μm minimum apertures were used to separate molluscs from sediments respectively. In the field, samples were fixed in 4% formalin. In the laboratory samples were first rinsed with water and then sorted and identified to species level under stereolight microscope. After that molluscs were preserved in 70% alcohol for any future study. Identification keys used were those of Mandahl-Bath (1954, 1988), WHO (1987) and Brown (1994). Simultaneously, water parameters such as dissolved oxygen, pH, temperature, conductivity and turbidity (transparency) were measured at the same sampling sites. Measurements of Oxygen, pH, temperature and conductivity were done by using Wagtech probes calibrated at the water Laboratory in Mwanza while transparency was measured using a secchi disc.

Data collected from the two lakes were used to estimate three aspects of taxonomic diversity: species composition averages number, size of organisms per m^2 and percentage of each species. One way Analysis of Variance (ANOVA) was used to test the significance of variation between various aspects of species diversity, abundance and water parameters measurements in the zones and hence in the two lakes. Shannon Weaver Index was used to estimate species diversity and richness. Water parameters were used to establish factors affecting diversity, abundance and distribution of molluscs species in different ecological zones of lakes Victoria and Burigi.

RESULTS

Molluscs species diversity

Table 1 shows the Molluscs species sampled from Lakes Victoria and Burigi. Four genera of streptoreuran (prosobranch) gastropods, two genera of basommatophoran gastropod and four genera of bivalve were recovered from sediments of Lake Victoria. Lake Burigi comprised of one genus of prosobranch gastropod and two genera of basommatophora gastropods only. The basommatophoran genera are *Bulinus* and *Biomphalaria*. *Biomphalaria* is represented by one species from both lakes, *Biomphalaria chaonomphala*, whereas *Bulinus* is represented by only one species from Lake Victoria, *Bulinus ugandae*. In Lake Burigi the genus is represented by three species namely *Bulinus forskali, B. globosus* and *B. ugandae*.

Two species of *Bellamya* occur in Lake Victoria namely *B. unicolor* and *B. constricta*. *Bellamya* was not present in Lake Burigi. Other prosobranch grastropods collected belong to the two genera of *Melanoides* and *Cleopatra*. One species *Melanoides tuberculata* was represented in both lakes whereas *Cleopatra bulimoides* occurred only in Lake Victoria.

A total of seventeen species of molluscs were recorded in the two lakes. There is higher diversity of molluscs species in Lake Victoria (15) than in Lake Burigi (5). Mara zone had eleven, Speke Gulf registered eight, and Mwanza Gulf six while Kagera zone registered seven. The mean Shannon diversity index was 0.2973 for Lake Burigi and 0.8587 for Lake Victoria. The range was 0.5614.

Table 1: The diversity of molluscs species from sediments sampled from Lakes Victoria and Burigi

Zone/Species	Lake Victoria				Lake Burigi
	Mara Zone	Speke Gulf	Mwanza Gulf	Bukoba Zone	
GASTROPODA					
Viviparidae					
Bellamya unicolor	P	P	P	A	A
Bellamya constricta	P	A	A	P	A
Thiaridae					
Cleopatra bulimoides	A	A	P	A	A
Melamoides turberculata	P	P	P	P	P
Bithnidae					
Gabbiella humerosa	P	P	P	A	A
Planorbidae	A	A	A	A	P
Bulinus globosus	A	A	A	A	P
Bulinus forskali	P	P	A	A	P
Bulinus ugandae	P	A	A	A	P
Biomphalaria chaonomphala					
BIVALVIA					
Corbiculidae					
Corbicula africana	P	P	P	P	A
Unionidae					
Caelatura acuminate	A	A	A	P	A
Caeletura alluaudi	P	A	A	A	A
Caeletura hauttecoeuri	P	P	P	A	A
Caelatura moncenti	P	P	A	P	A
Sphaeridae					
Sphaerium stuhlmanni	A	A	A	P	A
Sphaerium nyanzae	A	A	A	P	A
Eupera (Byssanodonta) parasitica	P	P	A	A	A
Number of species per station	11	8	6	7	5
Number of species per Lake		15		5	
Number of sp per Lake Victoria basin			17		

Molluscs relative abundance

Relative abundance of mollusc species in different ecological zones of lakes Victoria and Burigi are shown in Figure1. Only gastropods occurred in Lake Burigi. In Lake Victoria the gastropods dominated the catch in Mara zone, Speke Gulf and Mwanza Gulf. In Kagera zone the reverse was the case Bivalves dominated. *Melanoides tuberculata* dominated the catch in Lake Burigi and Mara zone, while *Bellamya unicolor* dominated in Mwanza Gulf and Speke Gulf followed by *Melanoides tuberculata*. In Kagera zone *Corbicula africana* (43.52%) dominated the catch, followed by *Sphaerium nyanzae* (20.63%), *S. stuhlmauni* (11.77%) and *Eupera (Byssanodonta) parasitica* (10.32%).

Molluscs densities and distribution

Table 2 shows the density and distribution of molluscs in Lakes Victoria and Burigi. The highest density of molluscs was from Speke Gulf (1366 ind./m^2). This was followed by Burigi (1101 ind./m^2), followed by Kagera zone (756 ind./m^2), Mara zone (686 ind./m^2) and Mwanza gulf (585 ind./m^2). *Melanoides tuberculata* and *Biomphalaria chaonomphala* were the only gastropods present in both the lakes. The difference in densities of molluscs in the two lakes were significant ($F=43.1071$, $P=0.0012$).

Table 2: Density and distribution of molluscs species from sediments sampled from Lakes Victoria and Burigi

	Lake Victoria				Lake Burigi
Species	Mara Zone	Speke Gulf	Mwanza Gulf	Bukoba Zone	
	No./m^2	No./m^2	No./m^2	No./m^2	
GASTROPODA					
Viviparidae					
Bellamya unicolor	10	8.45	234	-	-
Bellamya constricta	13	-	-	43	-
Thiaridae					
Cleopatra bulimoides					
Melanoides turberculata	182	175	130	17	893
Bithnidae					
Gabbiella humerosa	78	113	13	-	-
Planorbidae					
Bulinus globosus	-	-	-	-	52
Bulunus forskali	-	-	-	-	26
Bulinus ugandae	9	17	-	-	121
Biomphalaria chaonomphala	17	-	-	-	9
BIVALVIA					
Corbiculidae					
Corbicula africana	173	52	104	329	-
Unionidae					
Caelatura acuminate	-	-	26	35	-
Caelatura alluaudi	9	9	26	-	-
Caelatura hauttecoeuri	9	74	-	-	-
Caelatura monceti	9	56	-	9	-
Sphaeridae					
Sphaerium stuhlmanni	-	-	-	89	-
Suhaerium nyanzae	-	-	-	156	-
Eupera (Byssanodata) parasitica	87	25	-	78	-
Av. ind. per Zone	**686**	**1366**	**585**	**756**	**1101**
Av. ind. per Lake			**679**		**1101**

Physical and Chemical parameters

Figure 2 gives a summary of five different, physical and chemical parameters (Dissolved oxygen, Temperature, Conductivity, pH and Transparency) measured in the two lakes. Dissolved oxygen was lowest in Mara zone/Speke Gulf (8.05 mg/L) and highest in Kagera zone (9.45 mg/L) of Lake Victoria. This parameter however was not recorded in Lake Burigi. Temperature was higher in Mwanza Gulf (25.3°C) and Lake Burigi (25.20°C) and lower in Kagera zone (24.15°C) although the difference was not significant ($F=4.3142$ $P=0.1064$). Conductivity was highest in Kagera zone (123 µS/cm) followed by Lake Burigi (122.50 µS/cm). However there was a significant difference between the two lakes ($F=16.189$ $P=0.0158$). pH was 8.38 for Kagera zone and Lake Burigi while Speke Gulf registered 7.00. There was no significant difference between the two lakes ($F=7.6119$ $P=0.0509$). Transparency was lowest in Lake Burigi (0.5m) and highest in Mwanza Gulf (1.6m) from Lake Victoria.

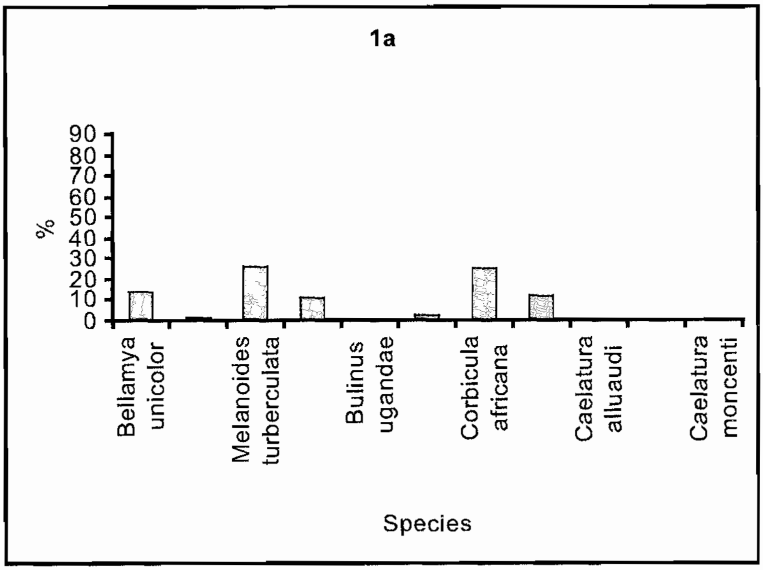

Figure 1a: Relative abundance of molluscs sampled from Mara zone

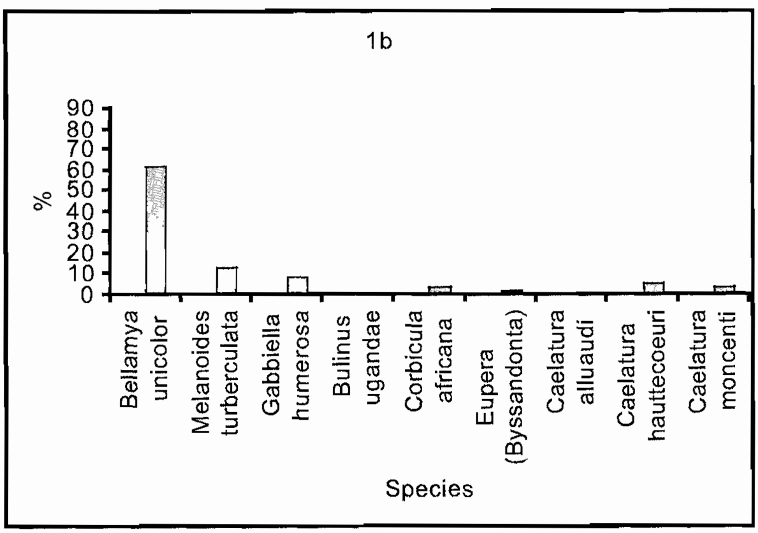

Figure 1b: Relative abundance of molluscs sampled from Speke Gulf

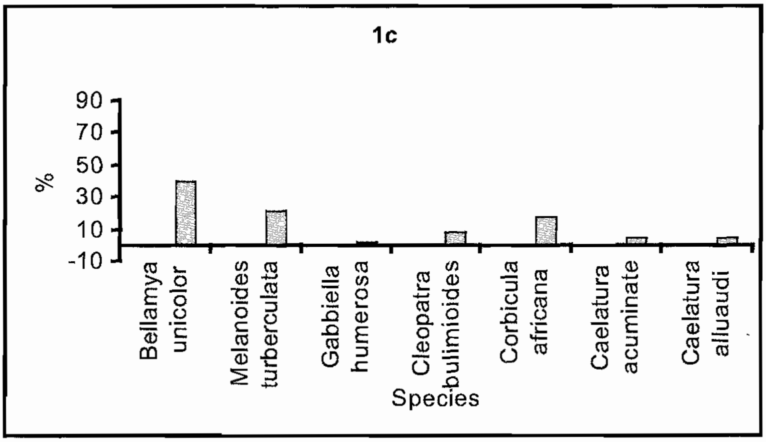

Figure 1c: Relative abundance of molluscs sampled from Mwanza Gulf

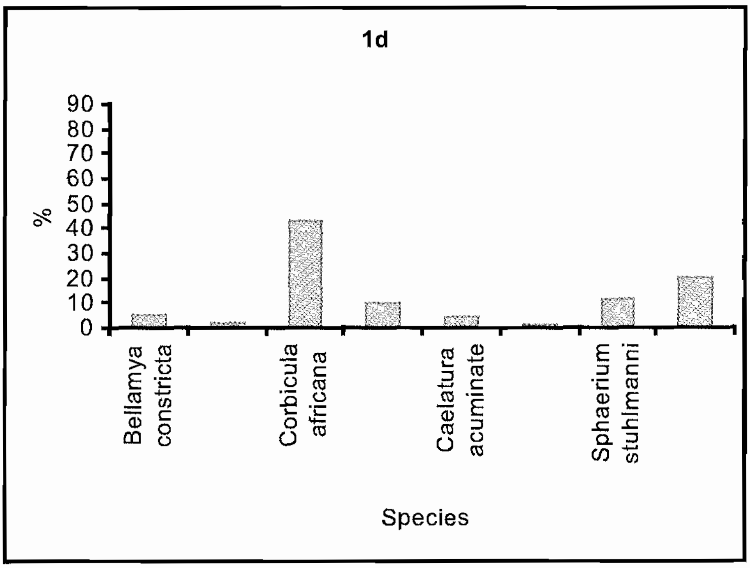

Figure 1d: Relative abundance of molluscs sampled from Kagera zone

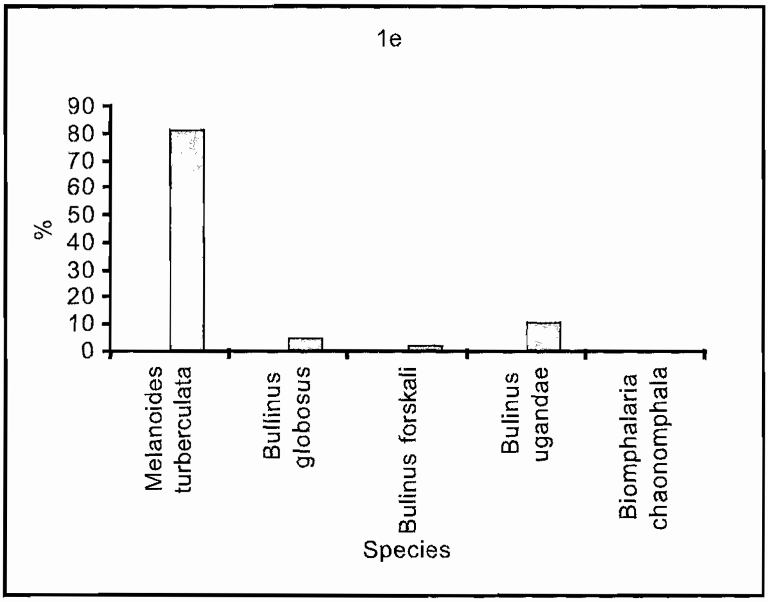

Figure 1e: Relative abundance of molluscs sampled from Lake Burigi

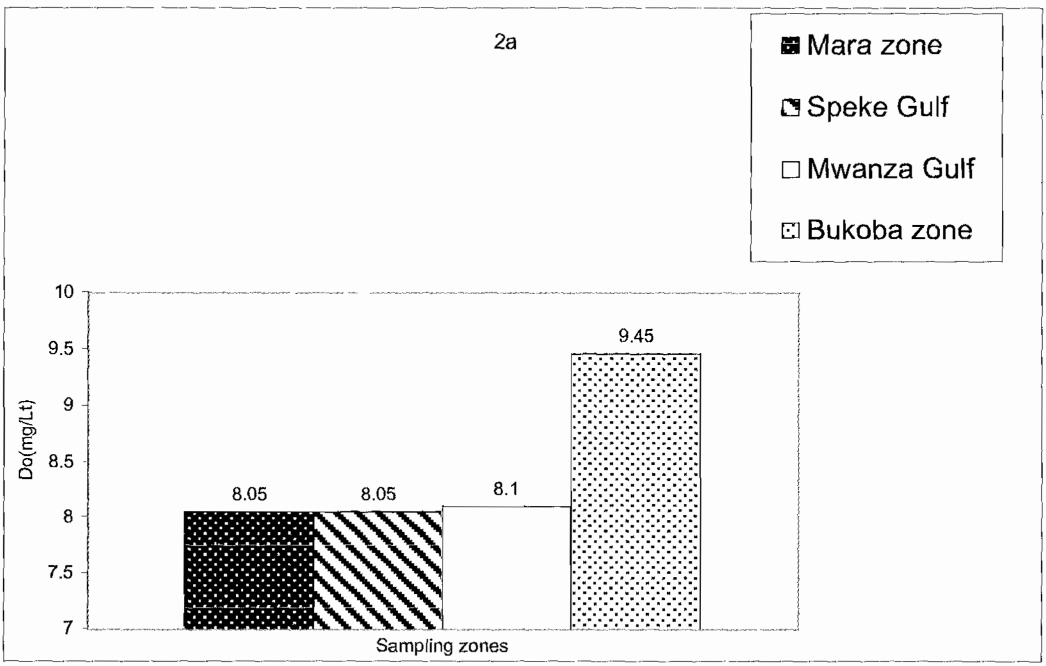

Figure 2a: Dissolved Oxygen measured in Lake Victoria

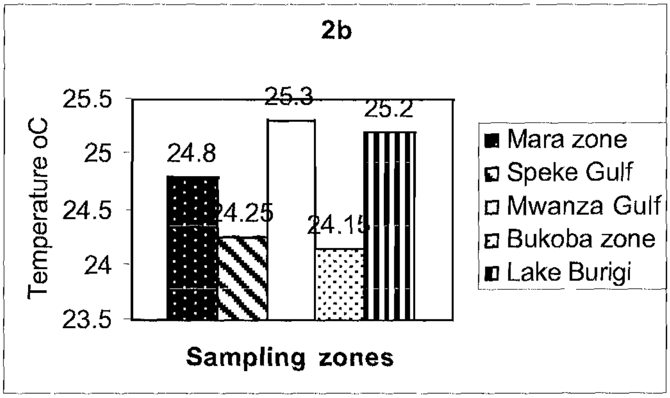

Figure 2b: Temperature measured in Lakes Victoria and Burugi

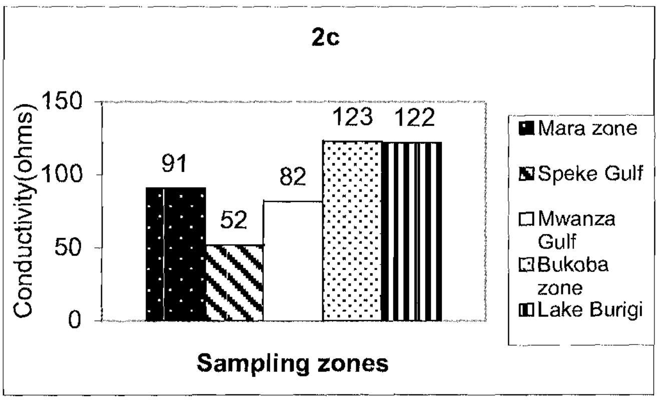

Figure 2c: Conductivity measured in Lakes Victoria and Burigi

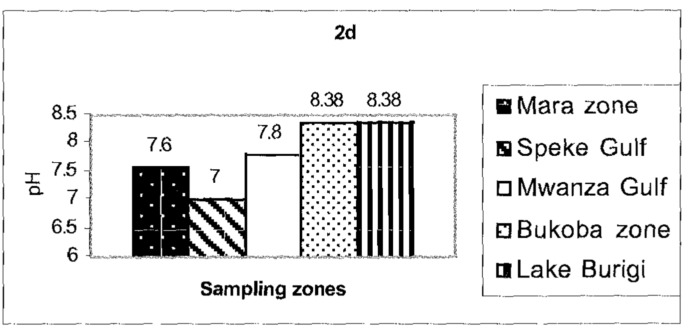

Figure 2d: pH measured in Lakes Victoria and Burigi

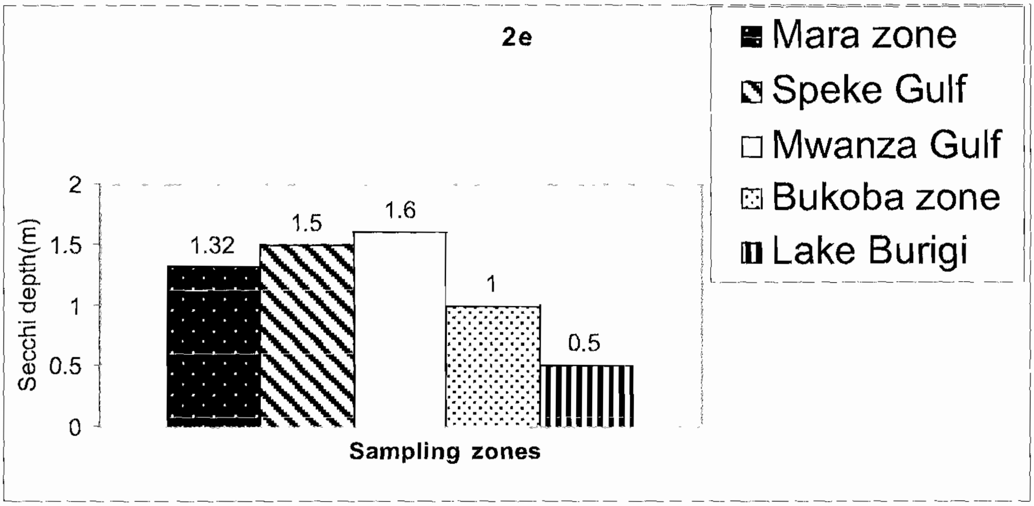

Figure 2e: Secchi depth measured in Lakes Victoria and Burigi

DISCUSSION

Physical and Chemical parameters

The water parameter values of the current study are comparable to those reported earlier from Mwanza Gulf by Akiyama et al. (1977). The decline in dissolved oxygen at the bottom water is associated with several factors: pollution by receiving organic materials from agricultural, urban and industrial activities and by siltation (Hecky 1993). Slight difference in temperature makes the water column stable thereby reducing re-oxygenated through mixing of water particularly at shallow depths. And the availability of dissolved oxygen in most lakes depends on the available photosynthetic active radiation suggesting that algal activities (biological oxygen demanding materials) in the surveyed areas were high, however, photosynthesis process was in low rate. On the other hand the increase in average of bottom temperature (24.8°C) in the main lake and the high temperature in Lake Burigi (25.20°C) is likely to have been attributed to global warming or/and increased suspended matter in the lakes.

The lowest value of secchi depth (0.5m) recorded from Lake Burigi is due to organic materials brought by effluent rivers, which favours the growth of phytoplankton. Higher degree of turbidity (low transparency) is attributed to the abundance of phytoplankton. The high conductivity in Kagera zone and Lake Burigi implies that the ionic content is high and can be inferred that, the high ionic content is due to high nutrient concentration. This is a result of decaying organic matter (Welzel 1983). Akiyama (1977) reported a high conductivity value of up to 122µS/cm. The higher pH recorded within Lake Burigi is likely due to increased photosynthetic and decreased respiratory activities in the ecosystem.

Molluscs diversity, abundance and distribution

In general the physical and chemical parameters measured in the two lakes were neither too low nor too high to limit any growth and survival of molluscs and other organisms. Good water parameter values (Dissolved oxygen, Temperature, Transparency Conductivity and pH) can account for high diversity of molluscs in Lake Victoria. The low diversity of molluscs in Lake Burigi could have been a result of higher degree of turbidity (corresponding to low transparency) high pH and conductivity. Brown (1994) indicated that turbid waters are unfavourable to some mollusc species. The presence of vegetation surrounding the satellite lakes at the bottom (per observation), and the presence of phytoplankton is indicated by Welzel (1983) as major determinant of the subsequent conditions of food supply, oxygen, ionic composition, pH, and numerous other factors that delimit the range and competitive abilities of benthic fauna. It is known that the decay of vegetation cause the decrease of oxygen content and consequently only few species which are able to survive under such conditions will survive (Welzel 1983). In the current study the high densities of organisms in Lake Burigi and in Kagera zone could be attributed to the higher offer of nutrients due to the lack of the competitor (low taxa) organisms (Welzel 1983).

This study has demonstrated that the prosobranch gastropod *Melanoides tuberculata* and a basommatophoran gastropod, *Biomphalaria chaonomphala* are common in the sediments of both lakes. Earlier studies in Lake Victoria by Corbert (1961) indicated *Melanoides* as being very common and ubiquitous. In Mwanza Gulf in the beginning of the 1980's *Melanoides* appeared to be far more common than *Bellamya* (Hoogerhoud 1986). However, Okedi (1990) found the reverse in Muchinson Bay (near Kampala). Surveys in northern Lake Victoria revealed the *Melanoides* as the dominant gastropod (Mothersil et al. 1980).

According to Brown (1994), *Melanoides tuberculata* seems to be the most tolerant to variations in salinity. In the case of *Bellamya* low salinity appears also to be unfavourable. Brown (1994) further indicated that, like pH, conductivity a measurement that express the cumulative effects of complex of chemical and physical properties, should be taken as a guide to the factors which actually determine the presence or absence of a species.

Molluscs as food for fish

In Lake Victoria, previous studies revealed the pre-*Lates* food web to be dominated by haplochromines, encompassing many trophic specialisations. Starting from phytoplankton and bottom deposits (detritus) a number of major pathways of energy have been demonstrated. One of them is via molluscs to various fish taxa (haplochromines, *Barbus altinalis, and Protopterus aethiopicus*) to piscivores. The molluscs, however appear now to be largely unexploited following the upsurge of the Nile perch resulting in the disappearance of the haplochromine molluscivores and decline in abundance of *Protopterus aethiopicus*.

According to Witte et al (1995) the two genera (*Melanoides* and *Bellamya*) used to be important food source for *Protopterus aethiopicus, Synodonts victoriae, Burbus altianalis* and for haplochromine molluscivores. Bivalves were included in the diets of molluscivorous fishes, but they were generally less important than gastropods. However it was also noted that in the mixed mollusc - insect eating haplochromines, bivalves predominated over gastropods in the diet.

Recent studies on food and feeding habits in Lake Victoria by Mwambungu et al. (2001) indicated that gastropods were the most consumed food item by *Lates niloticus* in Speke Gulf followed by Mara zone, Emin Pasha Gulf and the least preferred by the species in Mwanza Gulf. The study also showed that bivalves were preferred food items in Speke Gulf.

Studies done in lake Burigi indicate that the existing fishery include Haplochromines, *Protopterus, Synodontis, Brycinus,* Suchlike and *Mormyms* (per observation). The abundant gastropods are expected to support the existing fishery particularly of Haplochromines and *Protopterus*.

This study was done in trawlable areas only for Lake Victoria. It is recommended that further studies be conducted in non-trawlable areas in both seasons of hot rainy season and cool dry season in order to have a clear picture of diversity of these organisms in shallow waters (1-5meters)

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