Fish species composition, distribution and abundance in Lake Victoria basin, Kenya.

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Abstract

Fish species composition, distribution and abundance in Lake Victoria, Kenya and the surrounding dams and satellite lakes were studied from 1997 to 2001 The study revealed that lake Victoria had a total of 37 species representing ten families. *Lates niloticus* dominated the catches in terms of ichthyomass in Lake Victoria while haplochromine cichlids are still the richest in species diversity followed by *Barbus.* The haplochromines however showed an upward trend in biomass compared to 1980s.

In the satellite lakes, a total of 28 species belonging to ten families were recorded. Haplochromine cichlids were the most diverse group followed by *Barbus*. The endemic, *Oreochromis esculentus* was the dominant species among the tilapiines especially in Lake Kanyaboli. Lake Sare had the highest species richness and diversity.

In the dams *Clarias gariepinus* and *Oreochromis nilotica* was the most widely distributed species while *Barbus* had the richest species diversity. The endemic tilapiines, *Oreochromis esculentus* and *O. variabilis* were also recorded in the dams. The fish species assemblage in the dams and the satellite lakes demonstrates the importance of these water bodies in fish biodiversity conservation.

Key words*:* Lake Victoria, satellite lakes, dams, species composition, and distribution

Introduction

Lake Victoria was the home of unique and diverse fish fauna such as *Haplochromines, Labeo victoriarus* Boulenger*, Brycinus* spp*, Barbus* spp*, Momyrus* spp and *Synodontis spp* (Graham, 1929; Greenwood, 1966 and Ogari, 1984) that formed a special delicacy to the lakeshore communities. This diversity of Lake Victoria Harplochromines provided areas of scientific interest to biologist and taxonomists worldwide.

In the recent past, the human population around the lake basin has increased tremendously which in turn has increased socio-economic demands such as agricultural land, industrialization and urbanization. The effect of all this has been intense pressure through sediment pollution from poor agricultural practices, urban and industrial effluents resulting into serious environmental degradation of Lake Victoria.

In the period 1950–1962 non- endemic fish species such as *Oreochromis niloticus* (L.)*, O. leucostictus* (Trewavas)*, T. Zillii* (Gervais) *and Lates niloticus* (Linnaeus) were introduced into Lake Victoria (Ogari, 1984). Factors such as introduction of alien fish species, (Mwalo O. M. 1991, Welcomme, 1966, Fryer1973) increase in population, the use of wrong fishing gears and methods, (Ogutu-Ohwayo *et, al.1991*) destruction of the breeding and nursery grounds for the endemic fish species coupled with changes in environmental conditions (Ochumba *et, al* 1991) resulted in considerable changes in fish faunal composition. Today most of the endemic fish species are rarely encountered in Lake Victoria (Witte *et al*., 1992) and some are threatened with extinction in the Lake. (Ochumba *et, al* 1991, Witte *et al*., 1992). The endemic fish species that have now disappeared from Lake Victoria could now be found in the satellite lakes, dams and associated wetlands within the Lake basin .One main characteristic of these water bodies is the absence of *Lates niloticus* and most of these water bodies are heavily colonized by dense masses of emergent and sub-mergent aquatic macrophytes which form significant barriers to the dispersal of fish species intolerant to low oxygen and high turbidity levels such as *Lates niloticus* (Fish, 1956).

In view of reduced diversity and the threat of extinction of some native and exotic fish species from Lake Victoria, a need therefore, arose to ascertain and locate these threatened species in other water bodies in the Lake basin. This effort is directed at conserving this lost biodiversity of Lake Victoria in other water bodies and establishing the diversity and sanctuary sites where these species are still thought to be flourishing. This was the main objective of this study

Study area

Fig.1 shows the area in which this study was undertaken. Lake Victoria is the second largest fresh water lake in the world measuring 68,800 km^2. With a shoreline of 3,450m2, mean depth of 40m and maximum depth ranging from 70 to 90 m, it is shared between Kenya 6%, Uganda 43% and Tanzania 51%. It derives its water directly from rainfall which accounts for 90% of the total water into the Lake (Talling, 1966) .The Kenyan part of the lake is fed by several rivers including, Nyando, Sondu-Miriu, Awach, Nyando on the East and Southern side and Nzoia, Yala, Sio on the North and Western parts of the lake. The satellite lakes studied were Lakes Kanyaboli, Sare and Namboyo within the vicinity of Yala swamp in the northern part of Lake Victoria. Besides Lake Sare which discharges it waters directly into Lake Victoria the other two lakes discharges their water through underground seepage. The saline Lake Simbi in the southern part of Lake. Victoria lies at a distance of about 1 km from the shores of Nyanza Gulf. Further description of this lake can be found in Melack (1976, 1979). The dams are heavily colonized by dense masses of emergent and sub-mergent macrophytes (*Ceratophyllum, Cyperus papyrus, C. latifolia, C. immensus, Typha domingesis, Potamogeton schweinfurthii, Vossia cuspidate, Najas horrida* and *Nymphae spp.* A total of 15 dams were investigated

Materials and methods

Fish samples were collected using a bottom trawl net in all established stations in the Lake Victoria. At the river mouths multifilament nets of varying mesh sizes (1’’, $1^1/_4$’’, $1^1/_2$’’, 2’’, $2^1/_2$’’ , 3’’, $3^1/_2$’’,4’’, $4^1/_2$’’) were set overnight. In the satellite lakes and dams, varying mesh sizes of multifilament gillnet were cast in the open waters free from macrophytes colonization whereas in shallow areas and areas colonized by emergent and submerged aquatic macrophytes minnow traps were set overnight. Fish samples were sorted out according to families and species where possible. The total and individual weight of each species were taken to the nearest 0.1 g while total length for each specimen was measured to the nearest 0.1cm

In the lab and field identification was done using external morphological characteristics and identification keys by (Greenwood 1966; Boulenger 1915, 1916; Trewavas 1983 and Witte & Densen 1995).

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Results

Lake Victoria

***(a)* Fish species distribution and composition**

A total of 37 species were recorded out of the 21 sampled stations, representing eleven families (Cichlidae, Mochokidae, Schilbeidae, Clariidae Protopteridae, Cyprinidae, Characidae Centropomidae, Mormyridae Bagridae and Mastercembalidae) (Table 1). *Oreochromis niloticus, Yssichromis laparogramma* and *Y. fusiformis* were the most widely distributed cichlids species occurring in almost all the sampled stations. *Oreochromis leucostictus, Tilapia zilli* Gervais and *Tilapia rendalli*, *Astatotilapia SP Ptychromis sp, Paralabidochromis sp* were rare and occurred in only three stations. *Synodontis victoriae* Boulenger and *Synodontis afrofischeri* Hilgendorf belonging to the family Machokidae occurred in three stations and at the river mouths. *Schilbe intermedius* (Linnaeus), *Clarias gariepinus* Burchell,

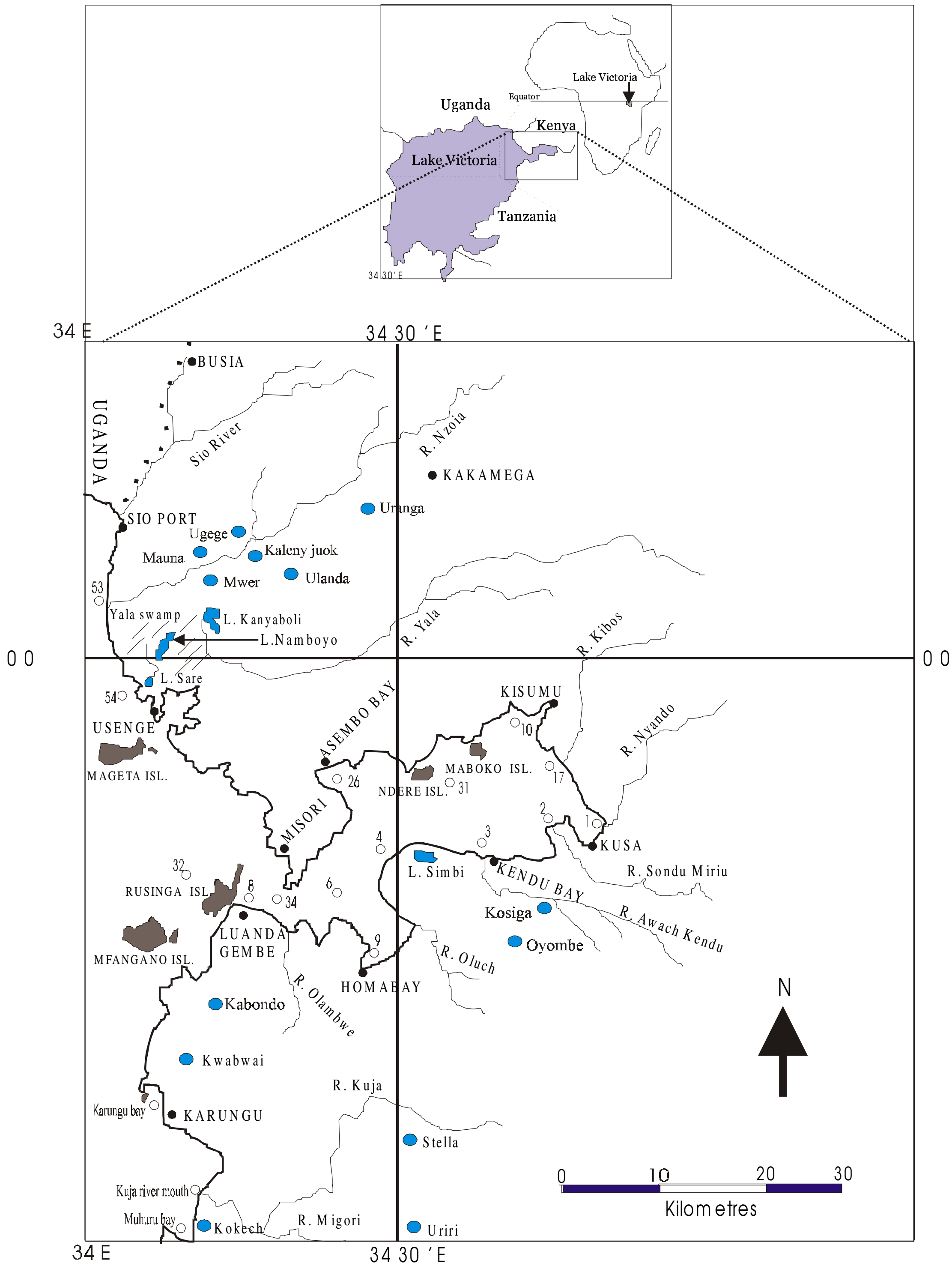

Figure 1: Map of Lake Victoria showing the sampled stations in the main lake, satellite lakes and dams

Protopterus aethiopicus Heckel occurred in most of the stations while *Bagrus docmac*, and the fresh water eel *Mastercembelus frenatus* were each recorded in only one station.

Rastrineobola argentea (Pellegrin) was the abundant cyprinid with a 100% occurrence at all the stations. *Barbus profundus, B. kersteni, B. jacksonii (*Gunthe*r), B. altianalis, B. apleurogramma* Boulenger *and B. trispilopleura* were each recorded in only two stations. Family Characidae was represented by *Brycinus sadleri* and *Brycinus jacksonii* with the latter accounting for 52.9% in all the stations. *Lates niloticus* was widely distributed and occurred in all the stations.

(b) Fish species abundance

Fish species abundance in (Fig. 2) terms of icthyomass was dominated by ***Lates niloticus*** constituting 60% followed by ***Oreochromis niloticus*** at 25%, ***Harplochromines*** 15%, ***Clarias gariepinus*** 5% and ***Protopterus aethiopicus*** at 2,5%. *Rastrineobola argentea* constituted less than 2.5% in these results due to the gear that was used and his does not mean that its biomass is low. Others constituted *Oreochromis leucostictus* (Trewavas)*, Tilapia rendallii, Synodontis victoriae, Synodontis afrofischeri, Schilbe intermedius,* and *Brycinus sadleri* each contributed less than 1% of the total biomass in the sampled stations.

Satellite lakes

Fish species distribution and composition

The composition and distribution in the satellite lakes in the Lake Victoria basin is shown in Table 2. A total of 28 species belonging to some ten families were recorded. The Haplochromine cichlids were not identified fully but they still lead in species number and biodiversity. Fishes of the genera *Barbus* were the second in terms of biodiversity. The species were not however, equally distributed in the satellite lakes, Lake Sare had the highest number and diversity for *Barbus* species while Lake Kanyaboli had the highest diversity for the haplochromines. All the three lakes (Table 2) were found to harbor *Oreochromis esculentus*, a native cichlid that is now thought to be commercially extinct in Lake Victoria. The native non-cichlids like the mormyrids, *Clarias alluaudi*, *Protopterus aethiopicus* and *Ctenopoma murei* were also recorded in the satellite lakes. In terms of species richness and biodiversity, Lake Sare is leading followed by Lake Kanyaboli and then Namboyo.

Dams

Fish species distribution and composition

The fish species composition and distribution in 15 dams within Lake Victoria basin is shown in Table 3. Some 25 species belonging to five families were recorded. The families found include Cyprinidae, Cichlidae, Clariidae, Mastacembalidae and Protopteridae. Cyprinidae dominated in the total number of species within a family. *Clarias gariepinus*, *Oreochromis niloticus* and *Barbus* a*pleurogramm* were the most widely distributed, occurring in all the dams. The endemic tilapiines, *Oreochromis esculentus* and *O. variabilis* were found mainly in the dams to the north of Lake Victoria.

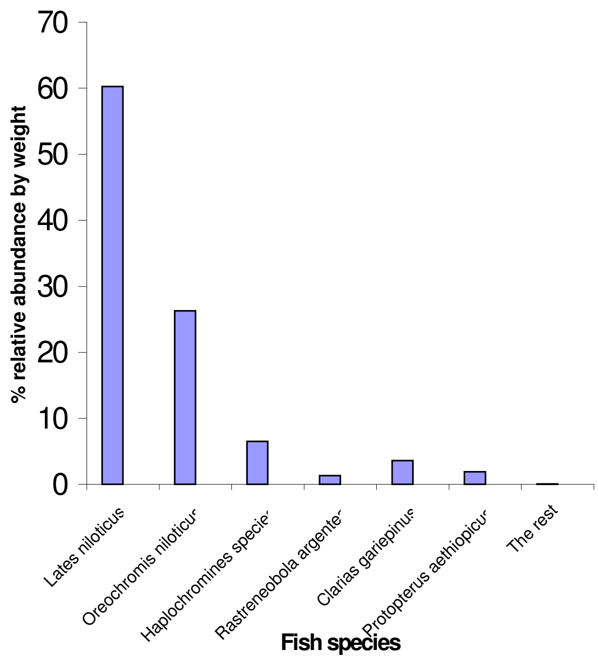

Fig. 2. Relative abundance of fish species in the sampled stations of Lake Victoria

Table 1.Fish species distribution in the sampled stations of Lake Victoria, Kenya

	SAMPLING STATIONS																	
TAXA	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**9**	**17**	**17A**	**26**	**30**	**31**	**36**	**36A**	**37**	**M. Mbili**	**Kuja**
Cichlidae																		
Oreochromis niloticus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
O. leucostictus			X						X									
Tilapia zillii		X	X															
Tilapia rendalli								X										
Xystichromis sp.							X	X	X				X					x
Yssichromis laparogramma			X	X	X	X	X	X	X		X	X	X	X		X	X	X
Y. uniforms						X	X	X	X			X		X		X	X	X
Astatostilapia sp.			X															X
Paralabidochromis kribensis			X				X											
P. chilotes				X			X								X			X
P. plagiodon				X			X								X			X
Paralabidochromis sp.							X											X
Ptychromis sp.						X	X											X
Other Haplochromines		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mochokidae																		
Synodontis afrofischeri			X											X				X
S.victoriae			X	X												X		
Schilbeidae																		
Schilbe intermedius			X	X											X	X		
Clariidae																		
Clarias gariepinus			X		X			X		X	X	X		X	X	X	X	
Propteridae																		
Protopterus aethiopicus							X	X		X		X	X					
Cyprinidae																		
Rastrineobola argentea	X	X			X	X	X	X	X	x	X	X	X	X	X	X	X	X
Barbus profundus		X																
Barbus kersteni		X																
Barbus trispilopleura			X					X										
Barbus jacksonii			X					X										
Barbu altianalis					X			X										
Barbus neumayeri					X											X		
Barbus apleurogramma					X													
Barbus cercops			X	X	X		X											
Characidae																		
Brycinus sadleri	X	X		X	X			X			X	X	X			X		
B. jacksonii	X	X									X	X						
Centropomidae																		
Lates niloticus	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mormyridae																		
Mormyrus kannume			X															
Gnathonemus longibarbis			X															
Marcusenius victoriae			X															
Bagridae																		
Bagrus docmac						X												
mastercembalidae																		
Mastercembelus frenatus																	X	

Discussion

The decline of the native fish species in Lake Victoria has been attributed to predation by the introduced Nile perch, use of wrong and destructive fishing gears especially around the river mouths and to some extent destruction of spawning and nursery grounds through human encroachment (Ogutu-Ohwayo *et, al.1991* Ochumba et, al.1991). Until the end of 1970s more than 80% of the demersal fish biomass of Lake Victoria consisted of haplochromine cichlids (Kudhongania & Cordone, 1974). Since the upsurge of *Lates niloticus* in the 1980s, the haplochromine stock and its fishery declined in the major parts of the Lake Victoria, particularly in the sub-littoral (6-20 m) and deepwater (>20 m) (Witte *et al*., 1992). Besides haplochromine cichlids, about 10 other genera, belonging to several families, contributed to the fisheries. Since the beginning of the century, the two indigenous tilapiine cichlids, *Oreochromis esculentus* and *O. variabilis* had been the most important target species (Fryer & Iles, 1972; Lowe-McConnell, 1987). These two species no longer occur in the lake in appreciable quantities. In addition to these cichlids, some native non-cichlid species of the family Mormyridae, Cyprinidae and Clariidae are threatened with extinction

Results from this study have revealed that these species now extinct or threatened in Lake Victoria, occur in substantial numbers in the satellite lakes and dams within the Lake Victoria basin. Further the results revealed that the haplochromines now occur in almost all parts of the lake and have increased in biomass. The second species rich in diversity after the haplochromines is *Barbus* with 8 species recorded in the lake and in the dams within L. Victoria basin. They were however more abundant in the dams than the main lake.

The introduced, *Oreochromis niloticus* is the dominant among the tilapiines in the main lake. *Tilapia rendalli* and *T. zillii* no longer occur in great quantities in both the main lake and the dams. The native non-cichlids rarely encountered in the lake and in the dams currently include *Bagrus docmac*, *Mormyrus kannume*, and *Mastercembelus frenatus. Lates nioloticus* still remains the most dominant species, followed by *Rastrineobola argentea* and *O. niloticus.*

Conclusion

These findings point to the importance of the satellite lakes and dams in the conservation of biodiversity. Lake Sare for example had the highest biodiversity among all the satellite lakes. During this study however it was noticed that in both Lake Kanyaboli and Sare, destructive fishing methods are in operation and these may cause further loss in biodiversity. Proper management guidelines such as mesh sizes, closed fishing seasons and banning of fishing in the breeding grounds must therefore be enforced to regulate and control the fishing activities in these water bodies.

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Table. 2 Fish species composition in satellite lakes of Lake Victoria basin, Kenya.

	LAKES			
TAXA	**KANYABOLI**	**SARE**	**NAMBOYO**	**SIMBI**
Anabatidae				
Ctenopoma murei	X	X		
Cyprinidae				
Barbus apleurogramma	X	X	X	-
Barbus paludinosus	X	X		-
Barbus karstenii	X	X		-
Barbus neumayeri		X		-
		X		-
Barbus altinalis				
				-
Cichlidae				
	X	X	X	-
Oreochromis niloticus				
Oreochromis esculentus	X	X	X	-
Oreochromis variabilis				-
		X		-
Oreochromis leucostictus				
Haplochromine spp.	X	X	X	-
Astatoreochromis alluaudi	X	X		-
Astatotilapia nubilus	X			-
Xystichromis phytophagous	X			-
Xystichromis sp.	X			-
Lipochromis maxillaris	X			-
Pseudocrenilabrus multicolor	X			-
Clariidae				-
	X	X		-
Clarias gariepinus				
Clarias alluadi	X	X		-
Protopteridae				-
	X	X		-
Protopterus aethiopicus				
Centropomidae				-
		X		-
Lates niloticus				
Mormyridae				-
		X		-
Mormyrus kannume				
		X		
Gnathonemus lonibarbis				
		X		
Marcusenius victorae				
Mochokidae				-
		X		-
Synodontis afrofischeri				
Centropomidae				-

ates niloticus		X		-
Characidae				-
Brycinus sadleri		X		-
Brycinus.jacksonii		X		-

Table 3. Fish species composition and distribution in dams of Lake Victoria basin, Kenya

TAXA	DAMS														
Cyprinidae	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Barbus apleurogramma	X	X	X	X	X		X		X		X	X	X	X	X
Barbus paludinosus		X		X		X	X		X	X	X	X	X	X	X
Barbus kerstenii	X			X					X		X	X		X	
Barbus neumayeri	X						X				X	X			
Barbus cercops									X		X			X	X
Barbus tripilospleura															X
Barbus jacksonii								X							
Barbus sp.											X				
Labeo victorianus								X	X						
Cichlidae															
Oreochromis niloticus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Oreochromis esculentus	X		X	X	X										
Oreochromis variabilis	X	X			X										
Oreochromis leucostictus					X						X	X	X	X	
Tilapia rendalli											X			X	
Haplochromine spp.	X	X		X	X	X						X			
Astatotilapia nubilus	X		X		X										
Xystichromis phytophagous	X		X												
Pseudocrenilabrus multicolor		X		X	X	X									

Clariidae															
Clarias gariepinus		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Clarias liocephalus															X
Protopteridae															
Protopterus aethiopicus									X					X	
Mastacembelidae															
Mastacembelus frenatus											X				

KEY; **1**.Ugege, **2**.Mauna, **3**.Mwer, **4**.Ulanda, **5**.Kalenjuok **6**.Uranga, **7**.Ufinya,

8.Oyombe, **9**.Kosigah, **10**.Migowa, **11**.Uriri, **12**.Stella, **13**.Olasi, **14**.Kokech, **15**.Ratang

Reference:

Boulenger, G. A. (1915) Catalogue of the fresh-water fishes of Africa III. *Trustees Brit. Mus. (Nat. Hist.)*

Boulenger, G. A. (1916) Catalogue of fresh-water fishes of Africa IV. *Trustees Brit. Mus. (Nat. Hist.)*

Fish, G .R. (1956) Some aspects of the respiration of six species of fish from Uganda. *J. Exp. Biol.* **33**: 186-195.

Fryer, G.& T. D. Iles, (1972). *The Cichlid Fishes of the Great Lakes of Africa: Their biology and evolution.* Oliver and Boyd, London, 641pp.

Fryer, G (.1973). The Lake Victoria fisheries: Some facts and fallacies, *Biological Conservation* **5:** 305-308

Graham, M. (1929) *The Victoria Nyanza and its fisheries. A report on the fishing surveys of Lake Victoria (1927-28*). Crown Agents Colonies, London.

Greenwood, P. H.,(1966) *The fishes of Uganda*. The Uganda Society, Kampala.(2nd edition).

Kudhongania, A. W. and A. J. Cordone, (1974) Batho-spatial distribution pattern and biomass estimate of the major demersal fishes in Lake Victoria. *Afr, J. Trop. Hydrobiol. Fish*. **3**:15-31.

Lowe-McConnell, R. H. (1987) *Ecological Studies in Tropical Fish Communities.* Cambridge University Press, London.

Melack, J. M. (1976) *Limnology and dynamics phytoplankton in equatorial African of lakes*. Ph. D. Thesis, Duke University, Durham. 453pp.

Melack, J. M. (1979) Photosynthesis and growth of *Spirulina platensis* (Cyanophyta) in an equatorial lake (Lake Simbi, Kenya*). Limnology and Oceanography* **8**: 68-78.

Mwalo O, M. (1991). The biology and distribution of *Harplochromis* Spp in the Nyanza gulf prior to the Total invasion of the gulf by Nile perch, Lates niloticus (L) *Proceedings of the Second EEC Regional Seminar on Recent Trends of Research on The Lake Victoria Fisheries*, 25-27th September 1991,Kisumu, Kenya; 73-83.

Ochumba, P.B.O., M. Gophen, and U. Pollinger, (1991). *Proceedings of the Second EEC Regional Seminar on Recent Trends of Research on The Lake Victoria Fisheries*, 25-27th September 1991,Kisumu, Kenya; 29-39.

Ogari, J (1984) *The biology of Lates niloticus (L.) in the Nyanza Gulf of Lake Victoria (Kenya) with special reference to the food and feeding habits*. M.Sc. thesis, University of Nairobi.

Ogutu-Owayo, R., R. T. Twongo, S. B. Wandera and J. B. Balirwa (1991) Suggestions to set mesh size limits and restrict the fishing methods and the type of fishing gears on Lakes Victoria and Kyoga. *Proceedings of the Second EEC Regional Seminar on Recent Trends of Research on The Lake Victoria Fisheries*, 25-27th September 1991,Kisumu, Kenya; 139-152.

Talling, J. F. (1966) The annual cycle of stratification and phytoplankton growth in Lake Victoria (E.Africa). *Int. Rev. Ges. Hydrobiol.* **51**:545-621.

Trewavas, E. (1983). The tilapiine fishes of the genera *Sarotherodon, Oreochromis* and *Danakilia*. *Publ. Br. Mus. Nat. Hist.,* London.

Welcomme, R.L. (1966) Recent changes in the stocks of *Tilapia* in Lake Victoria. *Nature* 212:52-54.

Witte, F and van W. L. T. Densen, (eds). (1995) *Fish Ftocks and Fisheries OF lake Victoria.* A handbook for field observations. Samara Publishing Limited, Cardigan (UK). 404p.

Witte, F., T. Goldschmidt, J. H. Wanink, M. J. P. Oijen, P. C. van, Goudswaard, E. L. M. Witte-Maas, and N. Bouton, (1992) The destruction of an endemic species flock: quantative data on the decline of the Haplochromine cichlids of Lake Victoria. *Env. Biol. Fish*.**34**: 1-28.