BIODIVERSITY O.F LAKE VICTORIA:

ITS CONSERVATION AND SUSTAINABLE USE

[THE UGANDAN VERSION]

Edited By:
Ogutu.Ohwayo, R. and Ndawula L.
National Agricultural Research Organisation,
Fisheries Resources Research Institute,
P. O. Box 343, Jinja, Uganda

December 2000

CHAPTER 10

Fish Species Diversity in the Victoria and Kyoga Lake Basins, Their Conservation and Sustainable Use

Abstract

Introduction of exotic fish species especially the Nile perch *Lates niloticus,* is believed to be responsible for the decline of fish species diversity in lakes Victoria, Kyoga and Nabugabo. About *60%* of the haplochromine cichlids are thought to have become extinct from L. Victoria due to predation by the Nile perch. However there are many lakes satelite to the lakes Victoria and Kyoga basins which still have fish fauna similar to that of the main lakes. Many of the satellite lakes are separated from the main lakes in, which Nile perch was introduced by extensive swamps that provide a barrier to Nile perch / A survey was carried out in a number of these satelite lakes and an inventory made of existing fish species. Their distribution and relative abundances were also determined. The lakes studied included Nawampasa, Nakuwa, Kawi, Lemwa, Gigate, Nyaguo, Agu, Nabugabo. Kayanja, Mburo, Kachera and Wamala./Some habitats within the main lakes Victoria and Kyoga, especially those with rocky outcrops·and macrophyte cover that provide refugia for endangered species from Nile perch, were also surveyed) Various stations along the River Nile were also sampled to quantify the fish species that still present. Kyoga minor lakes were found to have the highest number of fish species especially of haplochromine cichlids. Many haplochromine trophic groups that thought to be extinct from 1. Victoria still occur in these lakes.!Some of the satellite lakes, / especially lakes Kayugi, Mburo and Kachera still contain populations of *oreochromis. esculentus* that could be used as brood stock in fish farming. Many of these lakes should / therefore be protected for conservation offish species diversity.

Introduction

Fish species diversity in capture fisheries is very important as it provides choice for consumers and plasticity in employment opportunities. It is also important in the ecological functioning of the aquatic ecosystems. However,· human activities such as overfishing and species introductions can cause rapid reduction in fish species diversity. Loss of fish species diversity is a threat to the food supply, to the livelihood and health of the people and to the maintenance of ecological functioning in the aquatic ecosystems.

Lakes Victoria and Kyoga had a high species diversity with many species in common. Haplochromines were the most abundant group offishes in these lakes and formed at least 83% of the fish biomass in 1. Victoria before the I980s (Kudhongania & Cordone, 1974). They were important as human food and in evolutionary studies. Lake Victoria alone had over 300 haplochromine species, more than 99% of them endemic (van Oijien et aI., 1984; Witte et aI., 1992a). They occupied all trophic levels and played an important role in the flow of organic matter in these ecosystems. Up to eleven trophic groups of haplochromine cichlids were identified from the Mwanza Gulf alone (Witte & van Oijen, 1990). The original fish fauna had evolved into a trophic diversity that promoted efficient utilization of most of the available energy resources. Tilapiine cichlids and phytoplanktivorous haplochromines were the primary converters, *R. argentea* and several other small fishes preyed mainly on zooplankton while the major invertebrate/benthos feeders were *Clarias* spp, *Schilbe intermedius, Synodontis* spp. *Protopterus aethiopicus, Labeo victorianus* and several mormyrids (Twongo 1988). The major predator was *Bagrus docmac.* Two tilapiine species 0. *esculentus* and *Oreochromis. variabilis*

were the most important commercial species in these lakes and were found nowhere else except in the Victoria and Kyoga lake basins. The rivers in the two lake basins had a number of riverine species the commercially important of which was *L. victorianus.*

Stocks of the originally most important commercial species especially 0. *esculentus,* 0. *variabilis* and *L. victorinus* were depleted by human exploitation during the first half of the 20th century (Graham, 1929). Thereafter the fishery shifted to the smaller originally less preferred species, the haplochromines and *R. argentea.*

In an effort to sustain the declining fishery of large species, four exotic tilapiine species *Oreochromis niloticus,* 0. *leucostictus, Tilapia zillii* and *Tilapia melanopleura* were introduced into lakes Victoria and Kyoga from 1953 onwards. Later, the predatory Nile perch. *Lates niloticus* was introduced into L. Kyoga in 1955 and into L.Victoria towards the end of 1950s, to feed on the haplochromine cichlids and convert them into a larger fish, and also to develop a sport fishery (Ogutu-Ohwayo, 1990).

The introduced species upset the original ecological balance of the lake and caused changes in species diversity, the fishery and the environment of these lakes. Stocks of Nile perch increased rapidly from 1965 onwards in L. Kyoga and between 1977 and 1983 in the different parts of L.Victoria (Ogutu-Ohwayo 1990). As the stocks of Nile perch increased, fish species diversity, especially of the decreased rapidly. The contribution of haplochromines to fish biomass in the lake decreased from 83% recorded during the 1970s to the early 1980s (Kudhongania & Cordone) to less than I% from the late 1980s onwards (Okaronon et el 1985). About 60% of the haplochromine species are thought to have become extinct from L. Victoria alone (Witte et al 1992). Thereafter, the fishery of lakes Victoria and Kyoga became dominated by the two introduced species Nile perch and Nile tilapia. Only one native fish species, a cyprinid *R. argentea* initially remained dominant in the two lakes. Recent surveys have shown that populations of two zooplanktivores haplochromines *Yissichromis laparograma* and *Yssichromisfusiformis* are recovering in the offshore waters ofL. Victoria (Tumwebaze, 1997). The pelagic cyprinid *R. argentea,* a major prey species for juvenile Nile perch, is the only indigenous fish species of commercial importance.

A number of other changes occurred, especially in L. Victoria, at the time the introduced species became establised in these lakes. Algal biomass in L. Victoria increased four to five times, phytoplankton production doubled and water transparency decreased (Mugidde 1992, 1993). Algal species composition changed and became dominated by blue-green algae. Depletion of the detritivorous/phytoplanktivorous haplochromines which previously constituted about 50% of the total haplochromine biomass in L. Victoria, reduced grazing pressure and left much of the algae produced in the lake unconsumed. Decay of the excess organic matter depleted the water column of oxygen leading to hypoxic conditions in waters deeper than 40 m especially during periods of stratification. This reduced habitable space for many aerobic organisms and is thought to have forced deepwater haplochromines into shallower waters where they fell easy prey to Nile perch (Hecky 1993, Ogutu-Ohwayo & Recky 1991). The disruption and reduction in stocks of the trophically diverse haplochromine community by Nile perch changed the food web of the lakes and this seems to have reduced overall ecological efficiency of the lakes. This contributed to accumulation of organic matter and the changes described above.

There are many satellite lakes in the Victoria and Kyoga lake basins which still have fish fauna similar to that originally in the main lakes. Some of these lakes did not undergo introduction of species and are separated from the main lakes in which Nile perch was introduced, Many of the satellite lakes are also surrounded by extensive swamps which provided a barrier to Nile perch and other human impacts. Recent observations have indicated that most of the indigenous species depleted from the main lakes due to Nile perch predation pressure are still present in these satellite lakes (Ogutu-Ohwayo, *et al* 1998). There are also areas within the main lakes especially rocky outcrops and macrophytes habitats which provide refugia for endangered species both from Nile perch and anthropogenic impacts (Seehausen 1996; Namulemo 1997). A study was carried out in a number of the satelite lakes and selected habitats within the main lake to make an inventory of existing fish species, their distribution and relative abundance.

Objectives

The overall objective of the study was to assess the value of satellite lakes and other refugia in conservation of fish species diversity. The specific objectives are to: ;

- Make an inventory of the fish species in the various satellite lakes and selected habitats in lakes Victoria and Kyoga.

- Quantify the relative abundance and distribution of the various fish taxa within habitat types and lakes

- Compare the fish species diversity between the different lakes and habitats

Study Area, Material and Methods

The study was based on 7 Lake Kyoga minor lakes, 2 Koki lakes, 3 Nabugabo lakes and Lake Wamala. The Kyoga minor lakes were Nawampasa, Nakuwa, Gigate, Kawi, Lemwa, Nyaguo and Agu. The Nabugabo lakes were lakes Nabugabo, Kayanja and Kayugi. The Koki lakes were lakes Kachera and Mburo. Sampling was also carried out in the Napoleon Gulf of Lake Victoria at five stations namely Kiryowa, Kikondo, Kirinya, Rwamafuta and Cliff. Some stations along rivers Nile and Sio were also sampled

Fish specimen were obtained from experimental gillnets and basket traps. Three graded fleets of monofilament nets were used on each lake. Each fleet consisted of 6 panels of mesh sizes I, 1.5, 2, 2.5, 3, 4 and 5 inches stretched mesh. On the lakes without a region of submerged macrophytes like Kawi, Lemwa, Nakuwa and Lake Kyoga, the first fleet of nets was set along the shoreline, a second series was set 20 m and a third 200 m away and parallel to the shoreline. For lakes with macrophyte beds, like Nawampasa, Gigate, Nyaguo and Agu, the first fleet of nets was set along the shoreline, the second within the aquatic macrophytes and the third in the clear water. On L. Kyoga another fleet was set for offshore in the open water. In lake Victoria, three fleets of gillnets were set. Each fleet consisted of 8 panels of mesh sizes I, 1.5,2,2.5,3,4,5,6,7, and 8 inches. Rivers Nile and Sio were also sampled using graded fleets of gillnets similar to those used in L. Victoria.

The nets were set at dusk, left overnight and retreived the following morning. On retrieval, fish were sorted into taxonomic groups to species level whenever possible and the number

and weight of each taxa in each mesh size of net recorded. The fish that could not be identified in the field were preserved in 10% Formalin, labelled with date, habitat and time of capture and transported to laboratory for species identification. Identification of fish to species level was based on Greenwood 1981

Results

Species **Composition and Distribution**

Lake Kachera

Fish species composition for Koki lakes is shown in Table I. Experimental fishing was carried out at three stations namely openwater, Kiwolya and Rwebiriba. From the openwater station 4 fish taxa were recorded and they include Haplochromines (92%), 0. *esculentus (7%), Protopterus aethiopicus* (0.4%), and *Oreochromis leucosticus* (0.2%). From Kiwolya eight fish taxa were recorded the most abundant were haplochromines (46.2%), 0. *leucosticus* (16.7%), C. *liocephalus* (12.8%), 0. *eseulentus* (7.4%), C. *gariepinus* (3.4%), 0. *niloticus* (2.3%), *P. aethiopicus* (0.8%) and *T. zillii* (0.3%). From Rwebiriba six fish taxa were recorded and they included Haplochromines (85.8%), 0. *niloticus* (7.2%), *o.esculentus* (6.5%), C. *gariepinus* (0.2%), 0. *leucostictus* (0.2%) and *P. aethiopicus* (0.1%). The haplochromine cichlids included *H. squamipinnis, A.aeneocolor. A. alluaudi* and *A. nubila*

Lake Mburo

Experimental fishing was carried out at two stations namely Butibubiri and Nyanga. At Butibubiri, 6 fish taxa were recorded. These were haplochromines, 0. *esculentus,* 0. *niloticus,* O. *leucoslictus,* C. *gariepinus,* and *P. aelhiopicus.* The haplochromine cichlids belonged to four species namely *Aslalotilapia aeneocolor, Astatolilapia nubila, Astatoreochromis alluaudi* and *Harpagochromis squamipinnis.* From Nyanga five fish taxa were recorded and they included haplochromine cichlids, 0. *esculentus,* 0. *niloticus,* 0. *leucostictus* and C. *gariepinus.* The haplochromine species were as those recorded from Butibubiri.

Generally, the inshore sites had the highest number of fish although distribution varied with individual species. Numbers of . O. *esculentus.* C. *gariepinus* and *P. aethiopicus* were highest in the inshore fleets while 0. *niloticus* was most abundant in the middle fleets. Among the haplochromines, *H. squamipinnis* and *A. aeneocolor* were most abundant in the offshore fleets while *A. alluaudi* and *A. nubila* were most abundant in the inshore fleet.

LakeWamala

A total of 6 stations have been sampled namely Balikumi, Bukanaga, Katiko, Kilaza and Kubagwe. From Balikumi 3 fish taxa were recorded namely *A. nubila.* 0. *niloticus* and *P. aethiopicus.* Number of fish was highest in the inshore fleet. Eight fish taxa were recorded from Bukanaga namely haplochromines, 0. *leucostictus,* 0. *niloticus,* C. *gariepinus. Ctenopoma murieri, Clarias liocephalus. P. aethiojJicus* and *Clarias carsoni.* There were two species of haplochromines namely *A. nubila* and *Pseudocrenilabrus mullicolor.* From Kaliankoko, 4 species were recorded namely *A. nubila,* 0. *niloticus,* O. *leucostictus,* and *P.*

Table 1. Percent composition, by number, of fish taxa the Koki lakes

Fisb species	L. Mburo	L. Kacbera	Total
Haplochromiine	95.5	90.6	93.1
Oreochromis esculentus	3.2	4.3	3.7
Oreochromis leucostictus	0.3	1.7	1.0
Oreochromis niloticus	0.8	1.4	1.1
Protopterus aethiopicus	0.1	0.4	0.2
Clarias gariepinus	0.1	0.6	0.3
Clarias liocephalus	0	1.1	0.5
Tilapia zillii	0	0.01	0
Total	100	100	100

aethiopicus. P. aethiopicus occurred only in the offshore fleet while the rest of the species' were most abundant in the middle fleet. From Katiko 5 species were recorded and they included *0. niloticus, 0. leucosticus,* C. *gariepinus, P. aethiopicus* and *Tilapia zillii.* The 3 species recorded from Kilaza included *A. nubila, 0. niloticus,* and *0. leucosticus. 0. niloticus* occurred mostly offshore while the other two species were most dominant in the inshore fleet. The above 3 species were the ones also recorded from Kubagwe but were more abundant in the inshore fleet.

Overall, 9 fish taxa were recorded from L. Wamala. Numerically the most a bundant species was O. *niloticus* (55.5%), *haplochromines* (29.7%), *0. leucostictus* (7.8%), C. *gariepinus (3.9%), Ctenopoma murueri (1.1%),* C. *liocephalus (0.8), P. aethiopicus(0.8),* C. *carsoni(0.3%), T zillii (0.02%) and Xenoclarias spp.* Bukanaga had the highest number of species followed by Katiko, Kaliankoko, then Balikumi, Kilaza and Kubagwe

Nabugabo lakes

Three lakes were sampled namely, Nabugabo, Kayanja, and Kayugi. The species composition and relative abundance fish taxa recorded from the three Nabugabo lakes is shown in Table 2. In Lake Nabugabo, five stations were sampled namely River Juma mouth, Deadduck Bay, Lubira, Campsite and Openwater station. From Deadduck Bay station 9 fish taxa were recorded and they included haplochromines, *Brycinus sadleri, Lates niloticus, Tilapia rendalii, 0. leucostictus, 0. niloticus, ScMlbe intermedius, Synodontis afrofischeri* and *T. zillii.* From R. Juma mouth 10 fish taxa were recorded *namely* haplochromines, *B. Sadleri, Barbus kerstern, Gnathonemus longibarbis, L. niloticus, T. rendalii,* O. *leucostictus, 0. niloticus,* S. *afrofischeri* and *T. zillii.* From the Campsite 9 fish taxa recorded included haplochromines, *B. sadleri, L. niloticus, M. grahami, T. rendalii, 0. leucostictus, 0. niloticus, Schilbe intermedius* and *T. zillii.* From Lubira 4 fish taxa recorded included haplochromines, *B. sadleri, L. niloticus, 0. niloticus,* and S. *intermedius.Four* fish taxa were recorded from the openwater station namely haplochromines, *P. aethiopicus, L. niloticus* and S. *intermedius.* Four species of haplochromine cichlids were recorded from L. Nabugabo and they were *Astatotilapia velifer, Gaurochromis simpsoni, Paralabidochromis beadlei* and *A. alluaudi.* Overall thirteen fish taxa were recorded from L. Nabugabo and they included haplochromines, *B. sadleri, Barbus spp.,* G. *longibarbis, L. niloticus, M. grahami,* O. *rendalii, 0. leucostictus, 0. niloticus, P. aethiopicus,* S. *intermedius,* S. *afrofischeri* and *T. zillii.*

Ten fish taxa were recorded from L. Kayanja namely haplochromines, *B. kersterni, B. sadleri,* C. *gariepinus,* C. *liocephalus,* G. *victoriae, M grahami, 0. esculentus. 0. leucostictus, P. aethiopicus,* and *T. zillii.* The haplochromine species included *A. alluaudi, A. nubila, Astatotilapia spp.* and *Prognathochromis venator.*

From Lake Kayugi 7 fish taxa were recorded and they included haplochromines, *B. sadleri, B. kersterni,* G. *victoriae,* O. *esculentus, P. catostoma* and *P. aethiopicus.* The haplochromine cichlids included *A. velifer, A. nubila,* G. *simpsoni, A. ailuaudi* and *P. venator.*

Overall twelve fish taxa were recorded from the Nabugabo lakes and these were haplochromines, *B. sadleri, Barbus spp.,* G. *longibarbis, L. niloticus, M. grahami,* O.

Table 2. Percent composition by number of fish species from the Nabugabo lakes

Fish species	.Nabugabo	Kayanja	Kayugi	Total
Haplochromine	48.8	58.9	82.2	59.5
Barbus kersten	0.4	4.2	0.8	2.3
Brycinus sadleri	113	0.3	1.3	4.2
Clarias gariepinus	0	0.3	0	0.1
Clarias sp.	0	0.1	0	0.1
Gnathonemus victoriae	0	5.3	4.9	3.4
Gnathonemus longibarbis	0.2	0	0	0.1
Marcusenius grahami	0.1	23.7	0	IL6
Oreochromis esculentus	0	5.1	1.1	2.7
Oreochromis leucostictus	0.9	0.2	0	0.4
Protopteros aethiopicus	0.1	0.2	0.2	0.2
Tilapia zillii	0.9	1.7	0	1.1
Oreochromis	0.3	0	0	0.1
Synodontis afrofischeri	2.8	0	0	0.9
[ates niloticus	11	0	0	3.7
Oreochromis niloticus	22.2	0	0	7.5
Schilbe intermedius	1.0	0	0	0.3
Petrocephalus catastoma	0	0	9.7	1.6
Total	100	100	100	100

rendalii. 0. */eucostictus,* O. *escu/encus,* 0. *ni/oticus, P. aethiopicus.* S. *intermedius.* S. *afrofischeri* and *T zi//ii.* The haplochromines included *A. a//uaudi. A. ve/ifer. A. nubila.* G. *simpsoni. P. bead/ei. Astatotilapia* spp. and *P. venator.*

Lake **Victoria**

Sampling was carried out at five stations namely Kiryowa, Cliff, Kikondo, Kiryinya and Rwamafuta. Overall, twelve fish taxa were recorded as shown in Figure 1. Numerically, Nile perch was the most dominant (42.3%) followed by haplochromines (30.7%), *Oreochromis ni/oticus* (12.2%), *Tzi//ii* (8.9%), *Synodontis afrofischeri* (2.3 %) and *Brycinus sad/eri* (1.9%). Other species recorded in small numbers included *Mormyrus kannume, Oreochromis /eucostictus, Synodontis victoriae. C/arias gariepinus. Oreochromis variabilis.* and *Protopterus aethiopicus.* Fish species distribution varied with species as shown in Figure 2, but generally the highest number of fish was recorded from the inshore fleet followed by the middle and the offshore fleets. The average number of Nile perch, *Synodontis spp.* and *M kannume* increased from inshore to offshore while that of haplochromines, O. *niloticus* , *T zi//ii, B. sad/en', o./eucostictus,* C *gariepinus,* and *P. aethiopicus* decreased from inshore to offshore.. 0. *variabilis* was recorded only from the inshore nets. Number of fish species was highest at Rwamafuta (12) and Kikondo (12) each, followed by Kiryowa (II), Kirinya (10) and Cliff (8).

Among the haplochromines, twenty two species were recorded from the five stations as shown in Table 3. The names that appear in quotes are cheironyms. Number of haplochromine species was highest at Kiryowa (21) followed by Kikondo (18), Rwamafuta (16), Kirinya (8) and Cliff (8). Overall relative abundance of haplochromine species is shown in Figure 3. Numerically, the most dominant was *Astatoreochromis a//uaudi* (17.9%) followed by *Astatotilapia "unicuspid"* (14.8%), *Prognathochromis paraguiarti (12.7%), Para/abidochromis "ye//owbody"* (10.6%). *Para/abidochromis "go/dchest" (9.8%), Harpagochromis guiarti* (7.5%), *Astatotilapia nubi/a* (6.5%), *Astatotilapia "bicuspid" (4.2%). Neochromis "scraperteeth"* (3.2%), *Neochromis nigricans (2.8%), Para/abidochromis crassilabris* (1.6%), *Para/abidochromis "ve/vetb/ack"* (1.6%), *Para/abidochromis "ye//owbar"* (1.3%), *Neochromis pseudonigricans (1.2%), Para/abidochromis rockcribensis* (0.9%), *Astatoti/apia sp. (0.8%), Para/abidochromis "shortsnout" (0.7%). Para/abidochromis "b/ue deepbody"* (0.6%), *Pcyochromis xenognathus* (0.5%), *Para/abidochromis "sharpteeth"* (0.4%), *Para/abidochromis "bigeye" (0.4%), Para/abidochromis chi/otes* (0.2%) and *Para/abidochromis "curvedhead" (0.2%).* Distribution of the different haplochromine species varied with distance from the shoreline as indicated in Figure 4. *P. chi/otes, P. "bigeye"* and *"P. curved head"* occurred in the inshore fleet only. *A. "unicuspid"* were most abundant in the offshore fleet while the remaining species decreased from inshore to offshore.

River Nile

Seven fish taxa were recorded and they included, in order of abundance, *Mormynls kannume (37.9%), L. niloticus* (23.7%), haplochromines (22.0%), *Barbus a/tiana/is* (7.3%), B.sadleri . (3.1 %), 0. *niloticus* (2.1 %), O. variabilis (1.8%), M. macrocephalus (0.6%), Bagrus docmac *(0.6%), T zi/lii* (0.5%) and crabs (0.5%).

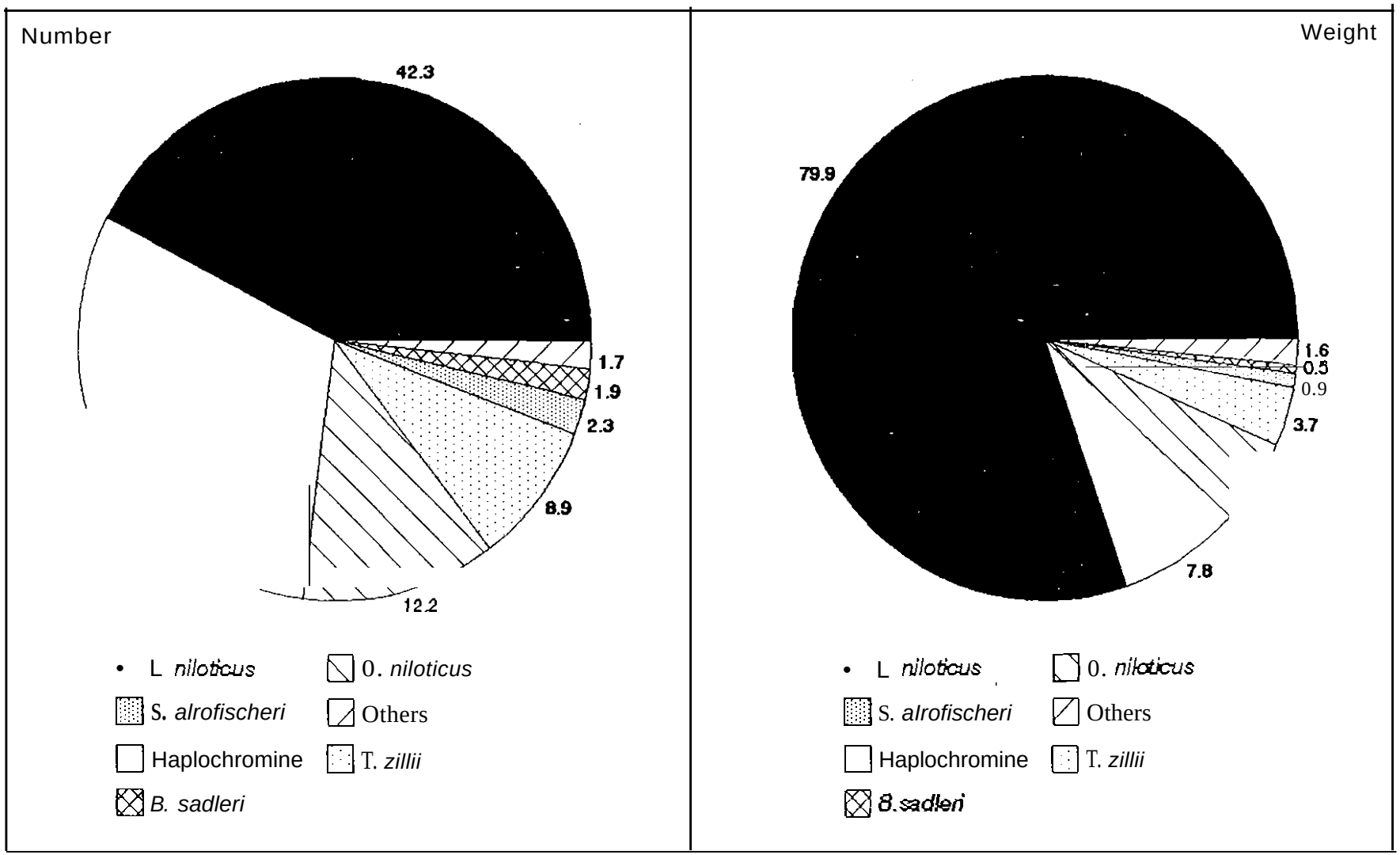


Fig. 1. Overall relative abundance of fish by number and weight.

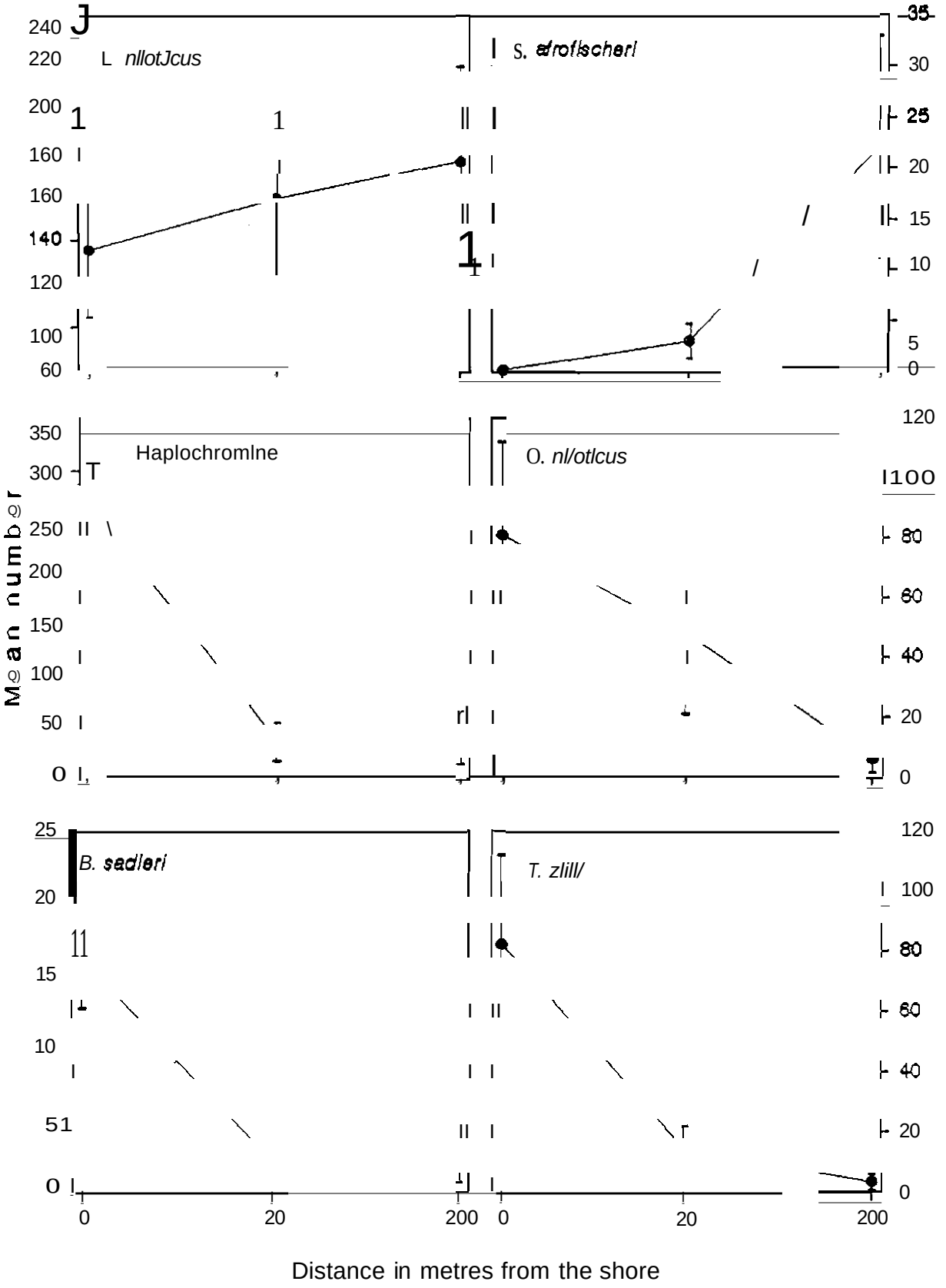
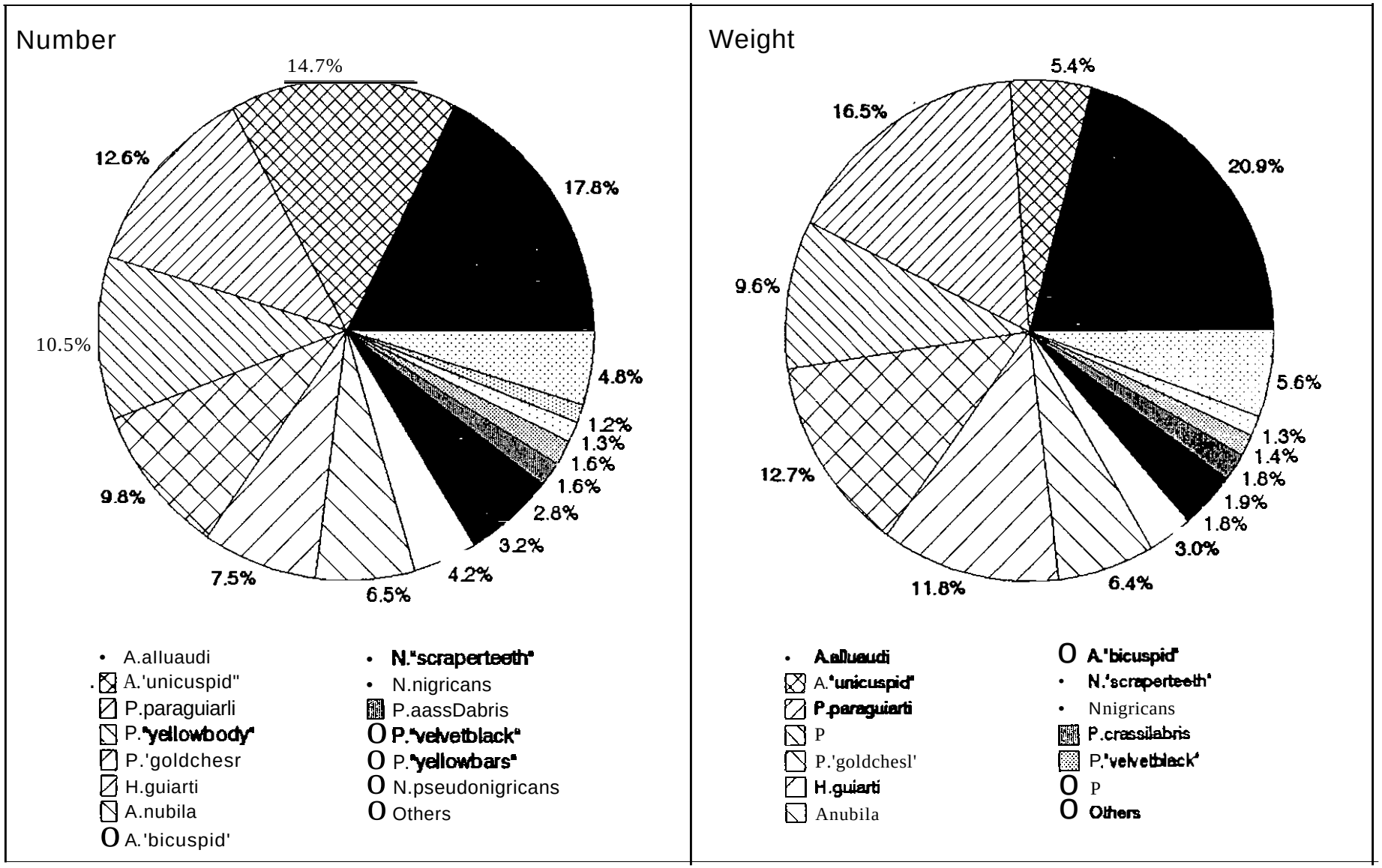


Fig. 2. Overall distribution of dominant fish taxa

Table 3. The numerical abundance ofhaplochromine species recorded from each station in the Napoleon Gulf (Lake Victoria)

Species	Kirinya	Kiryowa	Cliff	Kikondo	Rwama futa	Total
A.alluaudi	5	304	0	6	I	316
P."goldchest"	27	154	20	12	20	233
Astatotilapia sp.	0	18	0	0	0	18
A."bicuspid"	II	34	3	14	25	87
A.nubila	45	110	I	3	I	160
A."unicuspid"	8	45	27	289	3	372
Nnigricans	0	1	0	2	76	79
N pseudonigricans	0	0	0	4	29	33
N"scraperteeth"	0	18	12	45	I	76
P."big eye"	0	16	0	3	0	19
P."blue deep-body"	0	23	0	3	I	26
P.chilotes	I	3	0	12	I	16
P.crassilabris	0	18	0	7	13	38
P."curved head"	0	10	0	0	0	10
P."rockcribensis"	I	2	2	4	10	19
P."sharpteeth"	0	3	0	0	0	3
P."shortsnout"	0	2	0	0	3	5
P."velvetblack"	0	20	0	2	16	38
P."yellowbars"	0	10	0	4	0	14
P."yellowbody"	0	0	0	0	245	245
P.xenognathus	0	I	I	12	0	14
Hguiarti	22	113	7	33	0	175
Pparaguiarti	0	99	52	163	I	315
TOTAL	120	1004	125	618	446	2313



Rg. 3. Overall relative abundance of haplochromine species by number and weigh t

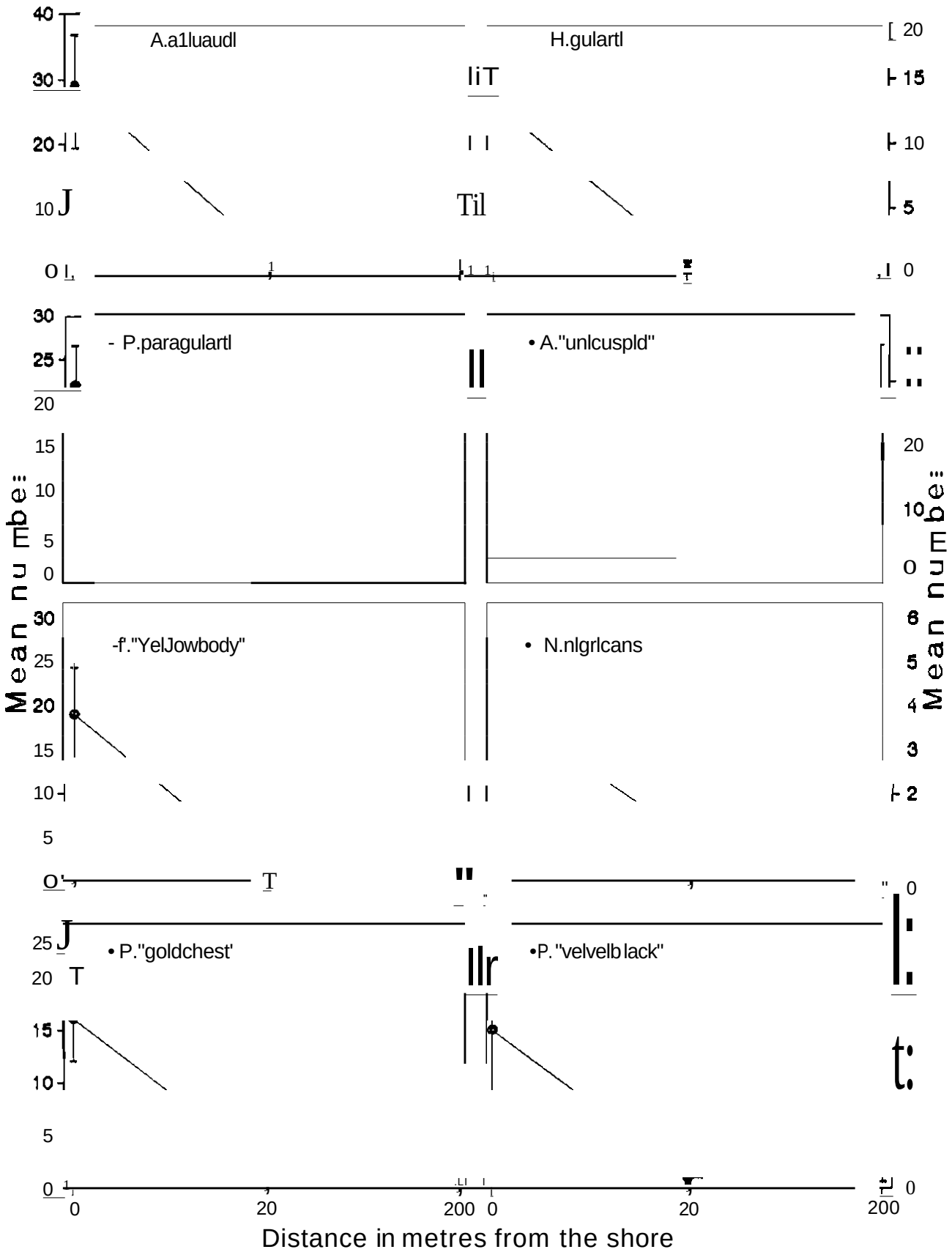


Fig. 4. Overall distribution of dominant haplochromine species

River Sio

Fifteen fish species were recorded from the mouth of R. Sio. Numerically, the most diminant species was Marcusenius grahami (23.8%), Barbus jacksonii (22.2%), Brycinus sadleri (20.1 %), S. victoriae (9.4%), Gnathonemus victoriae (5.1 %), L. niloticus (4.7%), S. afrofischeri (4.5%), Brycinus jacksonii (2.5%), C. gariepinus (2.0%), S. intermedius (1.8%), O. leucostictus (1.8%), O. niloticus (0.9%), L. Victorianus (0.5%), haplochromines (0.5%) and G. longibarbis (0.3%).

Kyoga

Eighteen taxa species were recorded and included haplochromines, *L. niloticus, Brycinus sadleri, Gnathonemus victoriae,* O. *niloticus, Synodontis victoriae. Synodontis afrofischeri. Mormyrus macrocephalus, T. zillii,* 0. *leucostictus. Schilbe intermedius. Protopterus aethiopicus,* C. *gariepinus. Labeo victorianus. Gnathonemus longibarbis, Barbus altianalis. Petrocephalus catastoma,* and *M kannume.* The highest number of species occurred in inshore (13) followed by offshore(l 1) and middle fleets (8). Fourteen haplochromine species were recorded as shown in Table 4. Their distribution varied with species but the highest number occurred inshore.

Kyoga satelite lakes

Species composition and relative abundance of the fish taxa recorded from the various Kyoga satelite lakes lakes is shown in Table 5. From Lake Nawampasa eleven fish taxa were recorded and included haplochromines *B.sadleri. Tzillii,* 0. *esculentus,* S. *victoriae.* S. *afrofischeri,* 0. *variabilis,* C. *gariepinus,* O. *leucostictus. P. gariepinus,* and 0. *niloticus,* S. *victoriae, B. sadler;'* 0. *esculentus,* were most abundant in the offshore nets while the rest occurred mostly in the the middlefleet. Twenty three species of haplochromines were recorded. The middlefleet had the highest number of haplochromine species (17), followed by the inshore (16) and the offshore fleets (13).

A total of twelve fish taxa were recorded and they included S. *afrofischeri.* S. *victoriae. Barbus spp., L. niloticus,* haplochromines, C. *liocephalus,* 0. *niloticus,* S. *intermedius. P. aethiopicus,* G. *victoriae.* 0. *leucostictus* and C. *gariepinus.* Number of species was highest in the middlefleet (11) followed by the inshore fleet (9) and the offshore fleet (2). The haplochromines have not yet been identified.

From L. Gigate 8 fish taxa wer recorded and they included haplochromines, *B. sadleri,* 0. *leucostictus,* O. *niloticus.* C. *gariepinus. P. aethiopicus,* S. *afrofischeri* and *Barbus* spp. Eighteen species of haplochromine cichlids were recorded. The middle fleet had the highest number of species.

Eight fish taxa were recorded from L. Kawi and they included haplochromines, *P. aethiopicus.* C. *gariepinus.* 0. *leucostictus,* 0. *esculentus,* S. *afrofischeri. Barbus* spp. and 0. *niloticus.* The highest number of fish was recorded from the inshore fleet followed by the offshore and middle fleets. Fourteen haplochromine species were identified from L. Kawi. The highest number of species was recorded from inshore fleet (13), followed by middle fleet (5) and the offshore fleet (3).

Table 4. The overall percentage composition of haplochromines by number from the Kyoga lake basin

	Lakes								
Species	Lemwa	Kawi	Agu	NyaguQ	Gigati	Nawampasa	Kyoga	Kyoga minor	Overall
Astatoreochromis al/uQudi	0.72	1.19	3.19	0.50	0.87	0.15	0.27	0.77	0.7.
AstQtotilapia latifasciata	0.00	0.00	0.64	0.00	0.69	1.41	0.00	0.70	0.66
Astatotilapia martini	0.10	0.00	0.00	0.7'	D.O'	0.00	0.00	0.05	0.05
AS/Gtoti/apia nubila	22.98	8.71	3.19	25.81	0.43	0.30	25.97	'.24	5.56
Astatotilapia "miniblack"	0.10	0.00	7.99	0.00	0.7'	5.90	0.00	2.01	1.89
Astatoti/apia 'fattoth"	5'.66	64.37	17.57	'9.13	26.22	39.03	0.00	36.56	3'.3'
Astatotilapia "macrops"	0.00	0.16	0.00	1.49	0.28	0.07	0.00	0.23	0.22
Astatotilapia "thicklipped"	0.00	0.00	0.00	0.00	0.07	D.O'	0.00	D.O'	D.O.
Astastotilapia "kyogaastato"	0.00	0.00	0.00	0.00	0.00	0.15	6.97	0.04	0'6
Gaurochromis sp	0.00	0.00	0.00	0.00	0.00	0.15	0.05	D.O'	D.O'
Haplochromis lividus	13.0'	0.63	'3.13	0.50	'3.7'	32.27	0.1'	31.98	30.0.
Lipochromis "blackcryptodon"	0.21	3.'8	0.6.	0.7.	0.39	0.82	0.1.	0.84	0.80
Lipochromis cryptodon	0.00	0.'0	0.00	0.50	0.05	0.00	0.00	0.09	0.08
Lipochromis microdon	0.00	0.2'	0.64	0.00	0.44	0.41	0.00	0.36	0.3'
Lipochromis obesus	0.00	2.69	'.79	0.50	0.97	0.67	0.00	,.10	1.03
Lipochromis parvidens	0.00	0.16	1.92	0.00	1.22	0.97	0.1'	0.91	0.87
Lipochromis "white"	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.02	0.02
Lipochromis maxillaris	0,00	0.32	0.64	0.00	0.05	0.52	0.00	0.20	0.19
Paralabidochromis "blackpara"	6.83	1.'3	0.00	0.00	0.02	0.00	40.73	0.75	3.19
Paralabidochromis "redfin "	0.10	0.63	0.00	0.00	0.25	0.59	0.00	0.35	0.32
Paralabidochromis "deep body"	0.00	0.00	0.00	0.00	D.O'	0.00	0,00	0.02	0.02
Prognathochromis argentus	0.82	2.38	5.11	0.00	0.60	'.79	0.00	1.91	1.79
Prognathochromis "long lowerjaw piscivore"	0.00	0.00	0.00	0.50	D.O'	0.00	0.00	D.O'	0.03
Prognathochromis pellegrini	0.00	0.00	2.56	0.00	0.00	3.79	0.00	0.98	0.92
Prognathochromis "silvermale"	0.00	0.00	0.00	1.99	0.00	0.00	0.00	0.07	0.07
Prognathochromis "black red tail piscivore"	0.00	0.00	0.00	0.7'	0.00	0.07	0.00	D.O'	D.O'
Prognathochromis "stilleto"	0.00	0.08	0.32	0.00	0.00	1.89	0.00	0.47	0.44
Prognathochromis "shovelmouth"	0.00	8.31	2.2.	13.90	160	2.90	19.27	2.98	3.97
Ptyochromis "gigatisheller"	0.00	0.00	0.00	0.25	0.04	D.O'	0.00	D.O'	0.03
Pyxichromis orthostoma	0.'1	'.35	0.00	1.99	0.3.	0.'1	0.27	0.86	0.82
Paralabidochromis "victoriae"	0.00	0.00	0.32	0.7.	0.00	0.00	0.00	D.O'	0.03
Xystichromis phytophangus	0.00	0.16	5.11	0.00	20.81	2.3'	0.27	11.13	10.'7
Yssichromis "lemwQ zooplanktivore"	0.21	0.16	0.00	0.00	0.00	0.00	0.00	D.O'	0.03
Yssichromis "kyoga zooplanktivore "	0.00	0.00	0.00	0.00	0.00	0.00	036	0.00	0.02
Paralabidochromis "earthquake"	0.00	0.00	0.00	0.00	0.00	0.00	2.32	0.00	0.1'
PrognQtHochromis guiarti	0.00	0.00	0.00	0.00	0.00	0.00	068	0.00	D.O'
XysticJrromis "flame back"	0.00	0.00	0.00	0.00	0.00	0.00	241	0.00	*015*
Paralabidochromis "silverpara"	0.00	0.00	0.00	0.00	0.07	0.00	0.00	DO'	003
Haplochromis "unicuspid"	0.00	0.00	0.00	0.00	0.00	0.07	0.00	002	0.02
ASlatoti/apia "redtailfattooth"	0.00	0.00	0.00	0.00	0.00	D.O.	0.00	0.01	0.01
Astatotilapia "pseudomartini"	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.05	005
Grand total	100	100	100	100	100	'00	100	'00	100

Table 5. Percent composition, by number, of fish taxa from the Kyoga minor lakes

Species	Nawampasa	Nakuwa	Lemwa	Kawi	Gigate	Nyaguo	Agu
L.nilolicus	0	12.8	0	0	0	0	0
0. *nilolicus*	0.1	3.7	0.3	0.1	03	0	0
Haplochromines	67.5	11.0	89.3	69.4	67.3	5.9	80.8
Cmurieri	0	0	1.0	0	0	0	7.1
A·frenalus	0	0	0	0	0	0.1	0
B.palludinosus	0	0	0	0	0	0.7	0
Sinlermedius	0	3.7	0	0	0	0	0
P. aelhiopicus	0.3	2.7	0	29.3	0.03	0.1	0.5
P.calaslOma	0	0	0	0	0	21.4	1.0
G. *viclOriae*	0	1.8	0	0	0	I.I	0
G.longibarbis	0	0	0	0	0	0.5	4.5
M.nigricans	0	0	0	0	0	2.1	1.0
M.grahami	0	0	0	0	0	0	0
M. macrocephalus	0	0	0	0	0	0.1	0
M.kannume	0	0	0	0	0	0	0
C.liocephalus	0	4.6	0	0	0	0	0
C.gariepinus	0.5	0.9	2.9	0.4	0.3	0.1	0
B.sadleri	26.0	0	0	0	31.1	67.4	0
*L. **viClorjanus***	0	0	0	0	0	0	0
B.altianalis	0	12.8	0	0	0	0	0
B.trispidopleura	0	0	0.3	0	0	0	0
Barbus sp.	0	0	2.3	0.1	0	0	0
S. *victoriae*	0.8	14.7	1.0	0	0	0.1	0
S.afrofischeri	0.7	32.1	0.3	0.2	0.03	0	1.0
0. *esculentus*	1.4	0	0.3	0.2	0	0.4	0
.00leucostictus	0.3	1.8	2.3	0.4	0.8	0.1	0.5
0. *variabilis*	0.7	0	0	0	0	0	0
Tzillii	1.5	0	0	0	0	0	3.5
TOlal	100	100	100	100	100	100	100

Table 6. Percent composition, by number, of fish taxa from different pilot zones

Species	L.Kyoga	Kyoga minor	Lake Victoria	Nabugabo lakes	Koki lakes	L.Wamala
Lates niloticus	15.4	0.2	42.3	3.9	0	0
Oreochromis ni/oticus	2.5	0.3	12.2	7.8	1.1	55.6
Haplochromine	46	507	30.7	61.6	92.8	29.8
Ctenopoma murieri	0	0.2	0	0	0	1.1
Afromastacembelus frenatus	0	0.1	0	0	0	0
Barbus paludinosus	0	0.2	0	0	0	0
Schilbe intermedius	0.3	0.1	0	0.4	0	0
Protopterus aethiopicus	0.3	3.5	0.1	0.2	0.2	0.7
Petrocephalus catastoma	0.1	5.0	0	1.7	0	0
Gnathonemus victoriae	14.7	OJ	0	0	0	0
Gnathonemus .longibarbis	0.1	0.2	0	0.1	0	0
Marcusenius nigricans	0	0.5	0	0	0	0
Marcusenius grahami	0	0	0	12.0	0	0
Mormyrus macrocephalus	0.6	0	0	0	0	0
Mormyrus kannume	+	+	0.5	0	0	0
Clarias liocephalus	0	0.1	0	0.1	0.6	0.8
Clarias gariepinus	0.2	0.4	0.2	0.1	0.4	3.9
Brycinus sadler!	15	35.3	1.9	4.3	0	0
Labeo victorianus	0.1	0	0	0	0	0
Barbus altianalis	0.1	0.2	0	0	0	0
Barbus trispido	0	+	0	0	0	0
Barbus sp.	0	0.1	0	0	0	0
Synodontis victoriae	1.7	0.4	0.4	0	0	0
Synodontis afrofischeri	0.7	0.7	2.3	1.0	0	0
Oreochromis esculentus	0	0.3	0	2.7	3.7	0
Oreochromis leucostictus	1.0	0.7	0.4	0.4	1.1	7.8
Oreochromis variabi/is	0	0.1	0.1	0	0	0
Ti/apia zi//ii	1.1	0.3	8.9	1.2	+	0.02
Barbus kersteni	0	0	0	2.4	0	0
Oreochromis rendalii	0	0	0	0.1	0	0

From L. Lemwa, 9 fish taxa were recorded and they included hap10chromines, C. *gariepinus,* O. *leucoslictus. Barbus spp.,* S. *vicloriae, Ctenopoma murieri,* S. *afrofischeri.* 0. *esculentus.· Barbus trispidopleura* and 0. *niloticus.* Eight species of haplochromines were identified from the lake and their number was highest in the inshore fleet (7) followed by the middle (5) and the offshore (3) fleets.

Fourt.een fish taxa were recorded from L. Nyaguo and they included *B. sadleri. P. calostoma,* haplochromines, *M. grahami,* G. *vicloriae, Barbus paludinosus,* G. *longibarbis.* 0. *esculentus,* S. *vicloriae, Maslacembalus frenatus, P. aethiopicus, M. kannume,* C. *gariepinus* and 0. *leucosticlus.* Number of species was highest at the openwater site (12), followed by middle and offshore fleets (9 each) and inshore fleet (7). Ten haplochromine species were recorded from the lake and their number was highest in the inshore and offshore. fleet (7) and then middle and openwater (4).

From L. Agu 9 fish taxa were recorded and they included haplochromines, C. *murieri, T. zillii,* G. *longibarbis, P. calosloma, M. nigricans.* S. *afrofischeri. P. aelhiopicus* and 0. *leucoslictus.* There were eleven haplochromine species recorded and their number was highest in middle and offshore fleets (8) and lowest in open and inshore fleets (5).

Discussion

Fish species composition of the different lake systems studied is shown in Tables 6 and 7. The satellite lakes in the Kyoga basin showed the highest number of fish taxa (25), followed by L. Kyoga (18), Nabugabo lakes (17), L. Victoria (12), Koki lakes (8) and L. Wamala (8). The Kyoga satellite lakes also showed the highest number of haplochromine species (24). Most of the trophic groups which which are thought to have disappeared from lakes Victoria and Kyoga were found to occur in these lakes. Among the Nabugabo satellite lakes L.Kayugi was found to be important lake since it still harbours healthy populations of O. *esculentus* that is believed to be extinct in lakes Victoria and Kyoga. In L.Victoria habitats with rocky outcrops and those aquatic macrophyte cover were found to be an important refugia for native fish species especially the surviving haplochrominesin the lake. Lakes Kachera and Mburo are also very important as they still have healthy populations of O. *esculentus* in addition to being an important source of income and food for natives. L. Wamala although it showed avery low number of fish species, it is an important source of income and protein for local population. Rivers Nile and Sio are considered special sites since they are a habitat to many riverine species such as *L. Victorianus* and *Barbus* spp. Which are rarely encountered in the main lakes. They are also a source of income and food for the natives.

Conclusion and Recomendations

The satelite lakes, and the rocky and macrophyte cover habitats surveyed during the study were found to be very important refugia for the native fish species that have disappeared from Lakes Victoria and Kyoga. These areas should therefore be conserved in order to maintain fish species diversity. Many of these lakes are also an impotant source of income and food for the local populations in their vicinity. They should therefore be managed properly for sustainable production.

Table 7. Number of fish species in each of the lakes surveyed

Lake	Haplochromines	Other species	Total
Kachera	4	7	11
Mburo	4	5	9
Wamala	2	8	10
Nabugabo	4	12	16
Kayanja	4	9	13
Kayugi	5	6	11
Victoria	22	11	33
R. Sio	I	14	15
R. Nile	+	6	6+
Kyoga	14	18	32
Nawampasa	23	10	33
Nakuwa	+	12	12 +
Kawi	14	7	21
Lemwa	8	8	16
Gigati	18	7	25
Nyaguo	to	13	23
Agu	11	8	19

REFERENCES

Gee, J.M., 1969. A comparison of certain aspects of the biology of *Lates ni/oticus* (Linne) in some East African lakes. *Rev. Zoo1. Bot. Afr. 80: 244-262*

Graham, M., 1929. TheVictoria Nyanza and its fisheries. A report on the fishery survey of Lake Victoria (1927-29). Crown Agents Colonies, London.

Hecky, R.E., 1993. Peter Kilham Memorial Lecture. The eutrophication of Lake Victoria. *Verh. Int. Verein. Limnol.* 25: 39-48

Humblyn, E.L., 1966. The food and feeding habits of Nile perch *Lates ni/oticus* (Linne) (pisces: Centropomidae). *Rev. Zool. Bot. Afr.* 74: *1-28*

Kudhongania, A.W. & Cordone, AJ., 1974. Bathiospatioal distribution pattern and biomass estimate of the major demersal fishes in Lake Victoria. *Afr.1. Trip. Hydrobiol. Fish. 3: 15-31*

Mugidde, R., 1992. Changes in phytoplankton primary production and biomass in Lake Victoria (Uganda). M.sc. Thesis, University of Manitoba. 84p.

Mugidde, R., 1993. The increase in phytoplankton production and biomass in Lake Victoria (Uganda). *Verh. Int. Verein. Limnol.* 25: 846-849

Namulemo, G. 1997. Distribtion, relative abundance and food of the surviving haplochromine cichlids in the littoral areas of Napoleon Gulf (Lake Victoria). Msc. Thesis Makerere University, Kampala 89pp

Ogutu-Ohwayo, R., 1990. The decline of native fish species diversity in lakes Victoria and Kyoga (East Africa) and the impact of introduced species, especially the Nile perch, *Lates ni/oticus,* and the Nile tilapia, *Oreochromis ni/oticus. Env. Bio1. Fish.* 27: *81-96*

Ogutu-Ohwayo, R., & R.E. Hecky, 1991. Fish introductions in Africa and some of their implications. *Can. J. Fish. Aquat. Sci.* 48 *(Suppl. I): 8-12.*

Ogutu-Ohwayo, R.; S. B. Wandera; G. Namulemo & D. Mbabazi, 1998: A paper presented for an International Conference for the Paradi Association and the Fisheries Society of Africa. African Fishes and Fisheries: Diversity and Utilisations, Grahamstown, South Africa, 13-19 September 1998.

Okedi,1., 1971a. Further observations on the ecology of the Nile perch *(Laces ni/oticus* Linne) in Lake Victoria and Lake Kyoga. *EAFFRG Ann. Rep. (1970): 42-55*

Okaronon, J. 0., Acere, T.O & Ocenodongo, D.L., 1985. The current state of the fisheries in the northern portion of Lake Victoria. pp. 89-98.1 :CIFA. Report of the third session of the sub-committee for the development and management of the fisheries of Lake Victoria. 4-5 October 1984. Jinja, Uganda. *FAG Fish. Rep.* 335. *FAG. Rome*

Ribbink, *A.l.*, 1987. African lakes and their fishes: Conservation scenarios and suggestions. *Env. Bioi. Fish.*. 19: 3-26

Seehausen, O. 1996. *Lake Victoria rock cichlids. Taxonomy. Ecology and Distribution* Verduijn Cichlids, Zevenhuizen, Netherlands

Tumwebaze, R., 1997. Application of hydroacoustics in fish stock assessment of Lake Victoria. MPhil Thesis. Department of Fisheries & Marine Biology. University of Bergen, Norway. 134 pp.

Twongo, T., 1998. Recent trends in the Fisheries of Lake Kioga. pp. 140-/51. I:CIFA. Report of the third session of the sub-committee for the development and management of the fisheries of Lake Victoria. 4-5 October 1984. linja, Uganda. *FAD Fish. Rep. 335. FAD. Rome*

Witte, F., & MJ.P. van Oijen, 1990. Taxonomy, ecology and fishery of Lake Victoria haplochromine trophic groups. *Zool. Verh.. Leiden* 262: 1-47

Witte, Goldschmidt, T., Goudswaard, P.C., Ligtvoet, W., Oijen. M.l.P. van & Wanink, T.H., I992a. Species extinction and concomittant ecological changes in Lake Victoria. *Neth. 1. Zool.* 42: 214-232

Witte, F. Goldschmidt, T., Goudswaard, P.C., Ligtvoet, W., Oijen, M.l.P. van & Wanink, *l.H.*, I992b. The destruction of an endemic species flock: quantitative data on the decline of the haplochromine cichlids of Lake Victoria. *Env. Bioi. Fish.* 34: 1-28

Worthington, E.B. A report on the fishing survey of Lake Albert and Kioga. London. Crown Agents 136 p.