THE ROLE OF SATELLITE LAKES IN CONSERVATION OF FISH SPECIES DIVERSITY IN THE LAKE KYOGA BASIN

FINAL REPORT OF
THE BIODIVERSITY SUPPORT PROGRAM MS83

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Summary

Title: "The Role of Satellite Lakes in Conservation of Fish Species Diversity in the Lake Kyoga Basin"

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Support from other sources

There was no direct support to the project from other sources. Since 1998, some information has been collected from these lakes by the Lake Victoria Environmental Management Project (LVEMP) which is supported by GEF and World Bank.

Abstract

Lakes Victoria and Kyoga had, a diverse fish fauna, which was important as food for local population and valuable in scientific studies. Over the past twenty years, the diversity of fish in these lakes had declined due to over-exploitation, introduction of new fish species including the piscivorous Nile perch and degradation of fish habitat. Studies of satellite lakes in the Victoria and Kyoga lake basins suggested that some of these lakes harboured species which had been lost from the main lakes. In order to better understand the extent, to which these satellite lakes may serve as refugia, a faunal survey was undertaken to determine the distribution and nature of the taxa found. Seven satellite lakes and the eastern end of the main Lake Kyoga adjacent to these minor lakes were surveyed over a two-year period for fish species diversity. A total of 68 fish species were recorded of which 41 were haplochromines. Almost all the native non cichlids which occurred in the main lakes (Victoria and Kyoga) before the Nile perch upsurge were recorded. Lakes Nawampasa, Gigati, Kawi, Agu and Nyaguo had the highest fish species and trophic diversity. The trophic diversity of haplochromines (based on Shannon Weaver Index) was highest in Lake Nawampasa (1.28), followed by Gigati (1.25), Kawi (1.18), Agu (0.8), Lemwa (0.81), Nyaguo (0.35) and was lowest in the main Lake Kyoga. Potential threats to these lakes were from collectors of ornamental fish species, especially the haplochromines, the spread of the predatory Nile perch and the water hyacinth, which are already in Lake Kyoga, and the destruction of macrophytes through harvesting of papyrus and reclamation for agriculture. The human population around these lakes harvested the fishes for food but the levels of exploitation were still low because the lakes were adjacent to main Lake Kyoga, the major supply of fish. Ornamental fish dealers were encouraged to start captive breeding of the fish for export to reduce pressure on the lakes and demonstrations for breeding were set up at FIRI in Jinja. Meetings and seminars were held with some of the communities living around the lakes sampled and the importance of fish species found in these lakes and the dangers of destructive practices discussed. Representatives of all taxa of fish caught from the lakes were preserved, catalogued and stored in the FIRI Museum. Results from this survey support the motion that these satellite lakes are important refugia for endemic diversity . Based on survey, we recommend that some of these lakes like Nawampasa, Gigati, Kawi, Agu and Nyaguo could be designated as conservation areas of species threatened in the main lakes. One of the factors that seem to have prevented the spread of Nile perch into Kyoga Minor lakes seems to have been the presence of extensive swamps around these lakes and the low oxygen levels that exist in these habitats. Clearing of swamps and vegetation that separate Kyoga Minor lakes from the main lake should be avoided to prevent Nile perch from spreading into these lakes.

THE MAIN TECHNICAL REPORT

Background

The Victoria and Kyoga Lake basin (Fig. 1) had similar and diverse fish fauna with many species which were found only in these lakes and a few satellite lakes within their basins (Graham 1929, Worthington 1929). These fishes were locally important as food and internationally valuable in ecological and evolutionary studies. The lakes had a trophically diverse fish community dominated by haplochromine cichlids. These haplochromines occupied all trophic levels in the lakes and played an important role in maintaining the stability of the ecosystem. Over-exploitation, introduction of predatory Nile perch, and environmental degradation was followed by drastic reduction in stocks of native fish species in the main water bodies of lakes Victoria and Kyoga (Ogutu-Ohwayo 1990, Ogutu-Ohwayo & Hecky 1991, Witte *et al* 1992). The decline in species and trophic diversity was accompanied by changes in the biological and physico-chemical conditions of Lake Victoria. Benthic invertebrates became dominated by chironomids, chaoborid larvae; *Caridina nilotica* and molluscs. Zooplankton composition changed from a predominance of calanoid to cyclopoid copepods (Mwebaza-Ndawula 1993). Algal biomass increased five times, phytoplankton production doubled, water transparency decreased and much of the lake became anoxic. This reduced habitable space for aerobic organisms. These changes made the ecosystem unstable, putting the lakes resources in jeopardy.

Preliminary observations in the Victoria Lake basins had shown that some of the fish species and trophic groups that were decimated from lakes Victoria and Kyoga survived in nearby satellite lakes (Ogutu-Ohwayo 1993, Chapman *et al* 1996). The Kyoga lake basin has many satellite lakes comprising of about 24 lakes of varying sizes most of which are within a swamp extending from the eastern shores of the main lakes (Figure 2). This study was designed to provide knowledge of the fish stocks and trophic diversity that were present in the Kyoga satellite lakes with the overall aim of finding out how these lakes can be used to conserve those fish species threatened in lakes Victoria and Kyoga.

Objectives

The specific objectives of the study were to:

a) develop an inventory of the fish species present in the Kyoga satellite lakes

b) rank the relative importance of the lakes in relation to their fish species diversity so as to recommend those that should be protected

c) preserve representative samples of fish species in FIRI Museum

d) examine how human activities such as fishing, collection of fish for ornamental trade and destruction of refugia affect fish species diversity in these lakes

e) sensitise the people around these lakes on their value and on the dangers of unsustainable fisheries and land use practices

f) examine the trophic diversity of haplochromines in these lakes

Study Area, Materials and Methods

The study was based on seven lakes in the Kyoga Lake basin (Figure 2). These were Lakes Lemwa, Kawi, Agu, Nyaguo, Gigati, Nakuwa and Nawampasa. Some data was also collected from Lake Kyoga in the region bordering the minor lakes. The lakes are located between longitude 32^0 051 E to 33^0 351 E and latitude 1^0 051 N to 1^0 551 N, at an altitude of 1037m above sea level. They are located in an extensive swamp east of Lake Kyoga. The swamp consists of two main arms. The south-eastern arm which is part of the Mpologoma swamp includes lakes Lemwa, Kawi, Nakuwa and Nawampasa The north eastern arm comprises lakes Agu, Nyaguo and Gigati. All the lakes were shallow with an average depth of 2.5 to 4.0 m (Table 1) .

Lake Kawi and Lake Lemwa were surrounded by papyrus, *Cyperus papyrus* right up to the open water edge. Lakes Nawampasa, Gigate, Nyaguo and Agu had a variety of habitats consisting of *Vossia cuspidata*, *Typha domingensis, C. papyrus*, and *Miscanthidium sp*. Between the shoreline vegetation and the open water of these lakes, there was a belt of dense aquatic macrophytes consisting of submerged plants *Ceratophyllum sp,* and, water lilies *Nymphaea spp*. Lake Nakuwa lacked the zone of dense aquatic macrophytes. The shoreline of Lake Kyoga was lined with *Eichornia crassipes*, *C. papyrus* and *V. cuspidata.*

Specimens of fish were obtained from experimental gill nets and basket traps. Three fleets of monofilament gill nets were used on every lake. Each fleet consisted of six panels of mesh sizes 1, 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 size of nets was set along the shoreline, a second series was set 20 m and a third series was set 100 m away and parallel to the shoreline. For the lakes with a dense macrophyte bed, like Nawampasa, Gigati, Nyaguo and Agu, the first series of nets was set along the shoreline, the second within the aquatic macrophytes and the third in the clear water. On Lake Kyoga other fleets nets were set offshore in the open water.

The nets were set at around dusk, left over night and retrieved the following morning for night catches and between 8.00 a.m. and dusk for day catches. On retrieval, fish was sorted into taxonomic groups to species level whenever possible and the number and weight of each taxa in each mesh size of gill net recorded. The fish that could not be worked on in the field were preserved for laboratory analysis. The fish species were preserved in 10% Formalin, labelled with date, habitat and time of capture and transported to the laboratory for species identification and food analysis. For preservation in the Museum the specimens were rinsed in water to remove the formaldehyde and

passed through different concentrations of alcohol before finally being stored in jars containing 70% ethanol. These jars were given identification numbers and catalogued using a computer program MUSE. They were then shelved in their appropriate families and genera.

In the laboratory, the preserved specimens were sorted into taxonomic groups. The total length of each fish was measured and the weight of each taxon in nets of various mesh sizes recorded to the nearest 0.01g using the triple beam balance. The species were identified using morphometric and meristic characteristics as in Greenwood (1981) and compared with previously identified specimens at the FIRI Museum. All the fishes were identified at least to genus level. Those that could not be identified were assigned a "chieronym". Samples of identified and unidentified specimens were sent to Leiden and Boston Universities for verification by experienced taxonomists. The different haplochromine taxa were preserved separately for food analysis.

The food of different haplochromine species as examined is as follows: - Fish specimens were cut open, the stomach of each fish dissected out and its degree of fullness scored as empty (0), < 1/4, ¼, ½, ¾ or full (1). The stomach was slit open and the contents emptied on to a petri dish. This was flooded with water and examined under a binocular microscope and if necessary, under a compound microscope. The food items were sorted and each item was identified as far as possible. Each food type was allotted points (0, 1, 2,4,8 and 16) depending on the relative importance of the food item in the stomach according to Hynes (1950).

Results

Species Composition and Diversity

A total of 68 fish species were recorded (Table 2 and 3). Of these, 41 species were haplochromines. The highest number of species was recorded in Lake Nawampasa (40), followed by lakes Nyaguo (34), Gigati (31), Kyoga (31), Agu (28), Kawi (26), Lemwa (22) and Nakuwa (14). The highest number of haplochromine species were recorded in Lake Nawampasa (27) followed by Gigati (25), Kawi (20), Agu (17), Nyaguo (16), Kyoga (15), Lemwa (12), and Nakuwa. Among non-haplochromines, the highest number of species was recorded in Lake Nyaguo (18), followed by Kyoga (16), Nakuwa (14), Nawampasa (13), Agu (11), Lemwa (10), Gigati and Kawi (6). Out of the 41 haplochromines recorded in the Kyoga Lake basin, 26 species were present in the minor lakes but absent in the main lake. Out of 27 non-haplochromines species recorded, 11 were present in the satellite lakes but absent in Lake Kyoga. On this basis, Lakes Nawampasa, Gigati, Kawi, Agu and Nyaguo were identified as having potential for conservation of endangered species.

Species diversity of haplochromines was higher in the satellite lakes than in Lake Kyoga. Species diversity of haplochromines based on Shannon Weaver Index, was highest in Lake Agu (1.68), followed by lakes Nawampasa (1.6), Kawi (1.27), Nyaguo (1.22), Gigati (1.17), Kyoga (1.08), Lemwa (1.07) and was lowest in Lake Nakuwa (0.22)

(Figure 3b). The diversity of non-haplochromines was highest in Lake Nakuwa (1.62), followed by lakes Nyaguo (1.59), Kyoga (1.51), Agu (1.16), Nawampasa (0.90), Gigati (0.57), Lemwa (0.40) and Kawi (0.34) (Figure 3a).

When the habitats were considered (Fig. 4), it was observed that lakes with submerged macrophytes had higher fish species diversity than those without submerged macrophytes. Fish species diversity decreased from the vegetated habitat inshore to open waters offshore. Protection of aquatic vegetation around the lakes would therefore, contribute towards conservation of fish species diversity in the lakes.

Food and Trophic Diversity of haplochromines

Trophic diversity was examined only for haplochromines and compared with the main lakes Kyoga and Victoria. 41 haplochromine species from the Kyoga lake basin were examined for food. The food was composed of cyanobacteria, fish eggs, green algae, yellow- green algae, detritus, fish, higher plant material, insects (mainly odonates, mayflies, dipterans) and molluscs. Overall, seven trophic groups comprising paedophages (31%), piscivores (21%), algal eaters (21%), insectivores (15%), higher plant eaters (5%), molluscivores (5%) and detrivores (5%) were recorded. All trophic groups were encountered in the minor lakes but only two trophic groups comprising insectivores (87%) and molluscivores (12%) occurred in the main lake. Trophic diversity varied considerably (Fig. 5). The Shannon Weaver diversity based on trophic groups was highest in Lake Nawampasa (1.28), followed by lakes Gigati (1.25), Kawi (1,18), Agu (0.89), Lemwa (0.81), Nyaguo (0.35) and lowest in Lake Kyoga.

Before the Nile perch upsurge, there were eleven trophic groups of haplochromines in Lake Victoria (Goldschmidt, 1996). These included insectivores, piscivores, higher plant eaters, zooplantivores, crab eaters, prawn eaters, peadophages, algae eaters, molluscivores, parasite eaters and detritivores. After the Nile perch upsurge and the decline in haplochromines only three trophic groups consisting of insectivores, prawn eaters and molluscivores are commonly recorded in Lake Victoria.

In Lake Kyoga, where Nile perch has been established the longest only two trophic groups of haplochromines are frequently encountered the insectivores and mollusciores. The current state in Kyoga satellite lakes is closer to that of Lakes Victoria and Kyoga before the Nile perch upsurge. The Kyoga Minor lakes are therefore important in conservation of some of the trophic groups depleted from Lake Victoria.

Impact of Human Activities

The potential threats to fish species diversity in Kyoga Minor lakes include: human exploitation, collection of ornamental fish for export, degradation of the fish habitat, spread of the Nile perch and water hyacinth. The human population around the lakes harvested the fishes for food but the levels of exploitation were generally low. The lakes were also near Lake Kyoga which was a major supply of fish. Human exploitation was therefore not yet a major threat to the fisheries of these lakes. Ornamental fish exporters

collected, mainly *Astatotilapia latifasciata* and *Haplochromis lividus,* principally from Lake Nawampasa. During the process other haplochromine species were discarded. Because of this wasteful practice, collecting of ornamental fish for export from Lake Nawampasa was suspended by the Fisheries Department. The other main threat to these lakes is due to harvesting of papyrus and the reclamation of land for agriculture. For instance, agricultural activities are currently encroaching the land around Lake Kawi. This not only destroy potential refugia but also exposes these shallow lakes to siltation. The spread of the Nile perch can also be dangerous to these lakes especially if the habitats of these lakes becomes suitable for its survival. The Nile perch has been prevented from spreading to many of the satellite lakes due the extensive swamps that separated the lakes from Lake Kyoga. The extensive vegetation cover also provided low oxygen conditions under which Nile perch may not survive. Destruction of these barriers may allow Nile perch to colonize and survive in these lakes and cause damage to the fish species diversity. Another potential problem may arise out of spread of water hyacinth into these lakes. The spread of the water hyacinth especially in the Lake Kyoga basin is currently under control using weavils.

Preservation of fish specimens at FIRI museum

A total of 105 samples of haplochromine species and 27 of other fish species have been preserved catalogued and kept in the FIRI Museum.

Education Programs

A series of community meetings were organised during field trips to discuss the value of these lakes in conservation of fish species diversity and the dangers of certain practices.

Conservation and Policy impact

Because of concern of overfishing these lakes the Fisheries Department has suspended collection of ornamental fish directly from Lake Nawampasa. The methodology for breeding these species in captivity is being developed at FIRI, Jinja.

Dissemination of Results

A booklet containing recommendations for conservation of fish species diversity is under preparation.

Training

One scientist (Mbabazi D.) carried out a study on **"The trophic structure and diversity of haplochromines among the Kyoga Minor Lakes"** as his thesis topic for his MSc at Makerere University

Recommended Project follow-up

This work is continuing under the Lake Victoria Environmental Management Project (LVEMP). This project will cover other components of aquatic biodiversity including algae, macrophytes, invertebrates, and other vertebrates, in addition to fish species diversity and ecology and environmental factors impacting biodiversity.

Project Personnel

There was no major change in personnel during the project life.

Personnel Evaluation

The results so far obtained are encouraging. Many fish species, which had been considered extinct from the Ugandan water bodies, are extant in the satellite lakes. The information gathered during this study will supplement already existing literature on these and closely related species. Further more, because of the information gained in this study, the LVEMP extended its fish biology and biodiversity conservation activities to the Kyoga Minor lakes.

Review of Report

Potential Reviewers of the project:

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Table 1. Area and average depth of the Kyoga Lake basin lakes sampled

Name of lake	Area (km^2)	Average depth (m)
Lemwa	10	3.1
Kawi	5	3.2
Agu	4	2.2
Nyaguo	33	2.4
Gigati	1.7	2.4
Nakuwa	8	2.6
Nawampasa	8	2.6
Kyoga	204.7	3.5

Table 2. The overall percentage composition of fish from different lakes in the Kyoga Lake Basin

	LAKES									
SPECIES	Agu	Nyaguo	Kawi	Lemwa	Gigate	Nawampasa	Nakuwa	Kyoga	Minor lakes	Overall
Lates niloticus	0.00	0.00	0.00	0.00	0.00	0.00	26.55	11.27	0.50	1.36
Oreochromis niloticus	0.00	0.27	0.00	0.15	0.22	0.08	3.39	2.33	0.24	0.40
Haplochromines	40.28	20.83	97.03	93.67	60.91	65.57	10.17	51.63	60.63	59.91
Ctenopoma murei	0.00	0.00	0.14	0.45	0.00	0.00	0.00	0.02	0.04	0.04
Tilapia zillii	0.47	0.00	0.00	0.00	0.00	0.62	0.56	1.22	0.10	0.19
Oreochromis variabilis	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.01	0.01
Oreochromis leucostictus	0.00	1.20	1.13	2.26	0.45	0.00	1.13	0.98	0.66	0.68
Oreochromis esculentus	0.95	0.80	0.57	0.90	0.03	1.03	0.56	0.00	0.38	0.35
Synodontis afrofischeri	0.95	0.93	0.85	0.45	0.00	3.26	20.34	0.07	1.02	0.94
Synodontis victoriae	0.00	4.14	0.00	0.30	0.00	1.28	10.73	1.33	0.84	0.88
Barbus spp	0.95	4.14	0.00	0.15	0.00	0.04	0.00	0.00	0.50	0.46
Barbus trispidopleura	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.01	0.01
Barbus altianalis	0.00	0.00	0.00	0.00	0.00	0.00	7.91	0.13	0.15	0.15
Labeo victorianus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.00	0.05
Brycinus sadleri	1.90	47.26	0.00	0.00	38.27	27.22	0.00	18.79	30.36	29.43
Clarias gariepinnus	0.00	0.13	0.28	1.51	0.12	0.41	1.13	0.09	0.28	0.27
Clarias liocephalus	0.00	0.00	0.00	0.00	0.00	0.12	2.82	0.00	0.07	0.06
Mormyrus kannume	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Mormyrus macrocephalus	0.47	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.31
Marcusenius grahami	6.16	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.19
Marcusenius nigricans	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.05
Gnathonemus longibarbis	41.71	3.47	0.00	0.00	0.00	0.00	0.00	0.07	1.67	1.54
Gnathonemus victoriae	4.74	10.41	0.00	0.00	0.00	0.04	1.13	10.90	1.31	2.08
Petrocephalus catastoma	1.42	2.40	0.00	0.00	0.00	0.00	0.00	0.09	0.31	0.29
Protopterus aethopicus	0.00	0.13	0.00	0.00	0.00	0.25	1.69	0.46	0.08	0.11
Afromastacembelus frenatus	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Schilbe intermedius	0.00	0.00	0.00	0.00	0.00	0.00	11.86	0.00	0.22	0.21
	100	100	100	100	100	100	100	100	100	100

Table 3. The overall percentage composition of haplochromines from different lakes in the Kyoga Lake Basin

	LAKES								Mean of Minor lakes	Mean of all lakes
HAPLOCHROMINE SPECIES	Lemwa	Kawi	Agu	Nyaguo	Gigate	Nawampasa	Nakuwa	Kyoga		
Astatoreochromis alluaudi	0.72	1.19	3.19	0.50	0.87	0.15	0.00	0.27	0.77	0.74
Astatotilapia latifasciata	0.00	0.00	0.64	0.00	0.69	1.41	0.00	0.00	0.70	0.65
Astatotilapia martini	0.10	0.00	0.00	0.74	0.04	0.00	0.00	0.00	0.05	0.05
Astatotilapia nubila	22.98	8.71	3.19	25.81	0.43	0.30	22.22	25.97	4.35	5.66
Astatotilapia "miniblack"	0.10	0.00	7.99	0.00	0.74	5.90	0.00	0.00	2.00	1.88
Astatotilapia "fattoth"	54.66	64.37	17.57	49.13	26.22	39.03	44.44	0.00	36.61	34.40
Astatotilapia "macrops"	0.00	0.16	0.00	1.49	0.28	0.07	0.00	0.00	0.23	0.22
Astatotilapia "thicklipped"	0.00	0.00	0.00	0.00	0.07	0.04	0.00	0.00	0.04	0.04
Astastotilapia "kyogaastato"	0.00	0.00	0.00	0.00	0.00	0.15	33.33	6.97	0.25	0.65
Gaurochromis sp	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.05	0.04	0.04
Haplochromis lividus	13.04	0.63	43.13	0.50	43.74	32.27	0.00	0.14	31.78	29.86
Lipochromis "blackcryptodon"	0.21	3.48	0.64	0.74	0.39	0.82	0.00	0.14	0.84	0.79
Lipochromis cryptodon	0.00	0.40	0.00	0.50	0.05	0.00	0.00	0.00	0.09	0.08
Lipochromis microdon	0.00	0.24	0.64	0.00	0.44	0.41	0.00	0.00	0.36	0.34
Lipochromis obesus	0.00	2.69	4.79	0.50	0.97	0.67	0.00	0.00	1.09	1.02
Lipochromis parvidens	0.00	0.16	1.92	0.00	1.22	0.97	0.00	0.14	0.91	0.86
Lipochromis "white"	0.00	0.16	0.00	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	0.00	0.20	0.19
Paralabidochromis "blackpara"	6.83	1.43	0.00	0.00	0.02	0.00	0.00	40.73	0.75	3.17
Paralabidochromis"redfin"	0.10	0.63	0.00	0.00	0.25	0.59	0.00	0.00	0.34	0.32
Paralabidochromis "deep body"	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.02	0.02
Prognathochromis argentus	0.62	2.38	5.11	0.00	0.60	4.79	0.00	0.00	1.89	1.78
Prognathochromis "long lower jaw piscivore"	0.00	0.00	0.00	0.50	0.04	0.00	0.00	0.00	0.04	0.03
Prognathochromis pellegrini	0.00	0.00	2.56	0.00	0.00	3.79	0.00	0.00	0.97	0.91
Prognathochromis "silvermale"	0.00	0.00	0.00	1.99	0.00	0.00	0.00	0.00	0.07	0.07
Prognathochromis "black red tail piscivore"	0.00	0.00	0.00	0.74	0.00	0.07	0.00	0.00	0.04	0.04
Prognathochromis "stilleto"	0.00	0.08	0.32	0.00	0.00	1.89	0.00	0.00	0.47	0.44

	LAKES								Mean of Minor lakes	Mean of all lakes
HAPLOCHROMINE SPECIES	Lemwa	Kawi	Agu	Nyaguo	Gigate	Nawampasa	Nakuwa	Kyoga		
Prognathochromis "shovelmouth"	0.00	8.31	2.24	13.90	1.60	2.90	0.00	19.27	2.96	3.95
Ptyochromis "gigatisheller"	0.00	0.00	0.00	0.25	0.04	0.04	0.00	0.00	0.04	0.03
Pyxichromis orthostoma	0.41	4.35	0.00	1.99	0.34	0.41	0.00	0.27	0.85	0.82
Paralabidochromis "victoriae"	0.00	0.00	0.32	0.74	0.00	0.00	0.00	0.00	0.04	0.03
Xystichromis phytophangus	0.00	0.16	5.11	0.00	20.81	2.34	0.00	0.27	11.06	10.40
Yssichromis "lemwa zooplanktivore"	0.21	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.03
Yssichromis "kyoga zooplanktivore"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0.02
Paralabidochromis "earthquake"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.32	0.00	0.14
Prognathochromis guiarti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.04
Paralabidochromis "flame back"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.41	0.00	0.15
Paralabidochromis "silverpara"	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.04	0.03
Haplochromis "unicuspid"	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.02	0.02
Astatotilapia "redtailfattooth"	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.01	0.01
Astatotilapia "pseudomartini"	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.05	0.05
Grand total	100	100	100	100	100	100	100	100	100	100

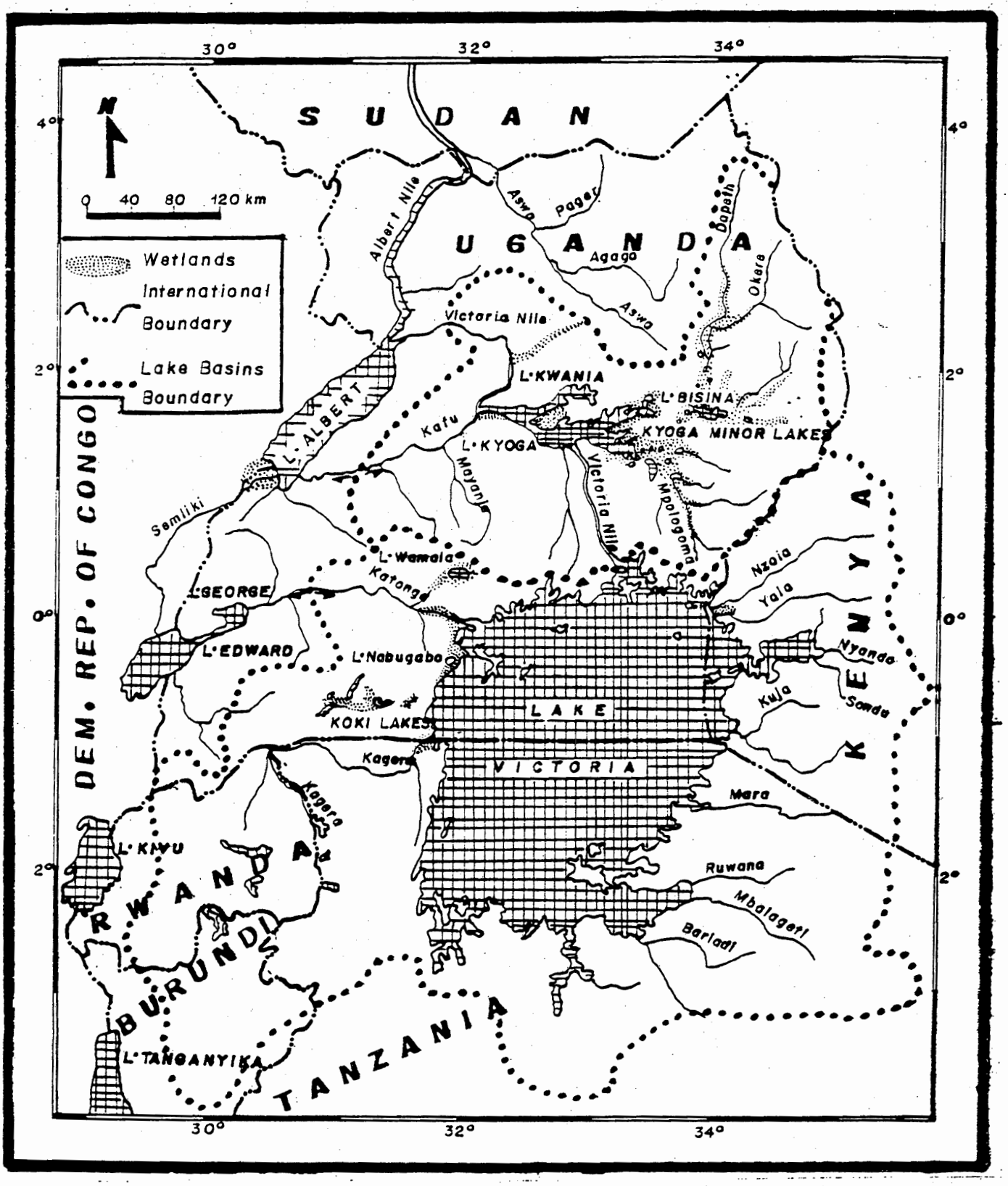

Fig. 1. **Map of Uganda showing the Victoria and Kyoga Lake Basins.**

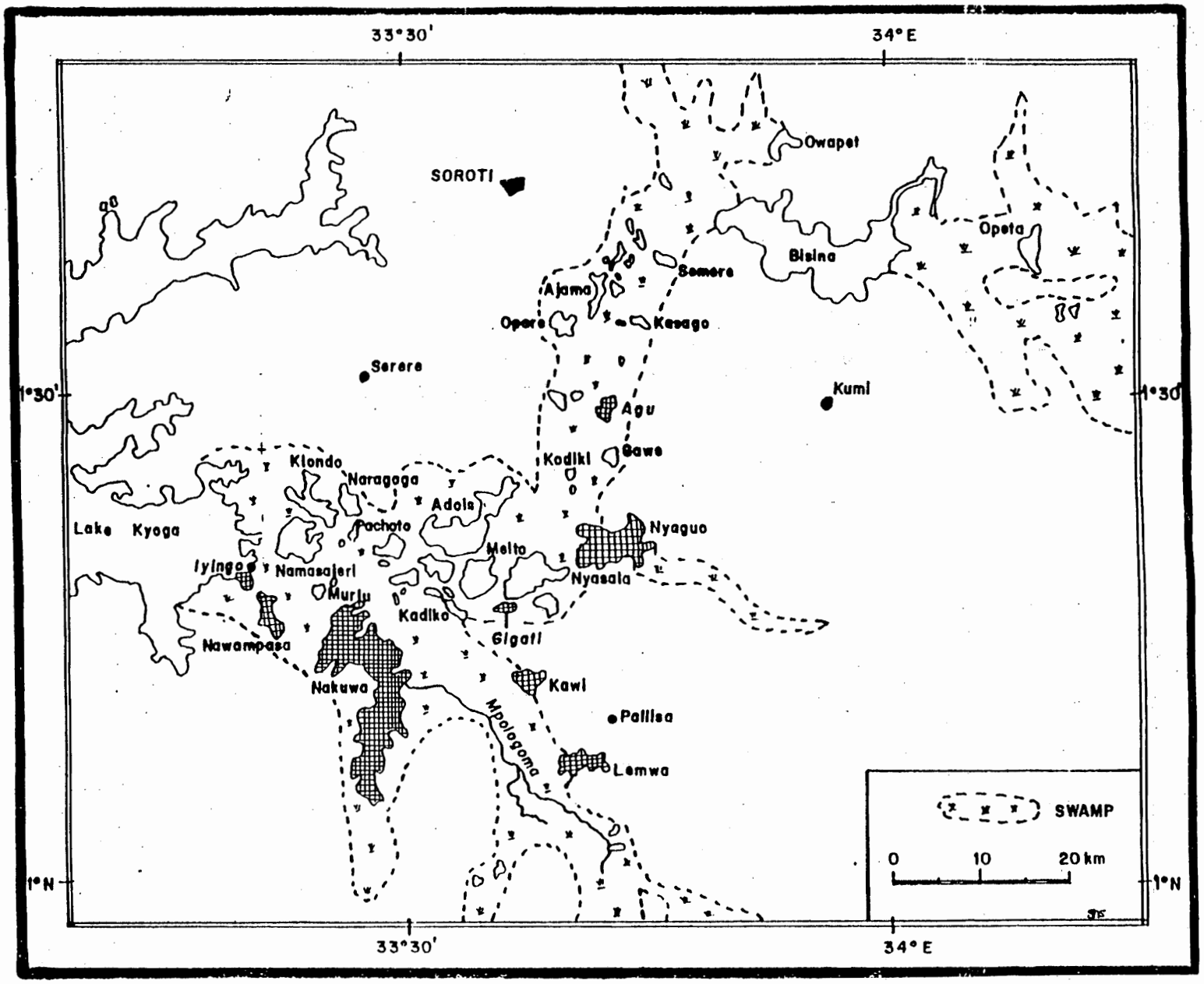

Fig. 2 Amap of Lake Kyoga Minor lakes. Sampled lakes are shaded.

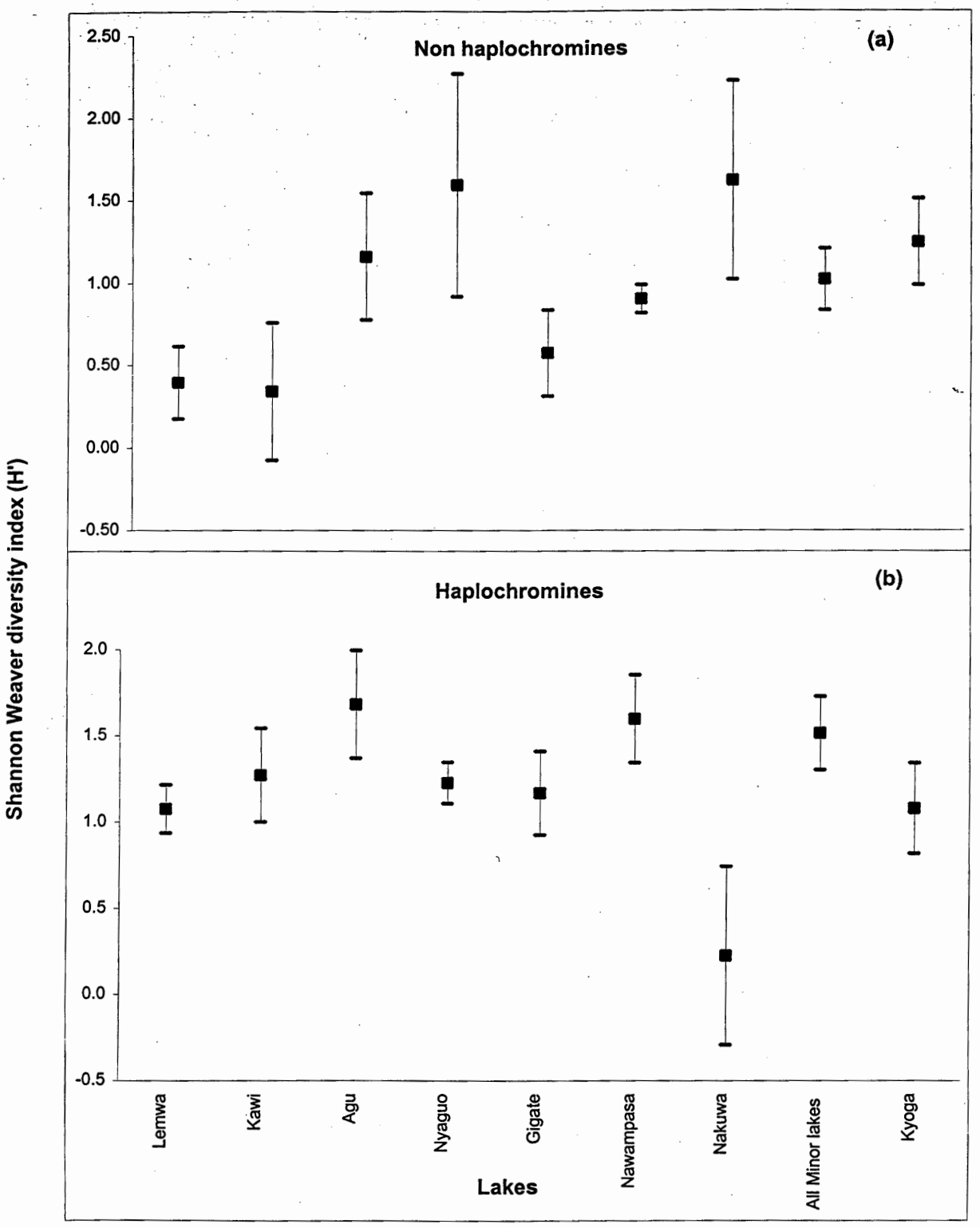

Fig. 3 Comparison of Shannon Weaver index of diversity of fish species from the different lakes. Vertical bars represent the upper and lower limits (P<0.005).

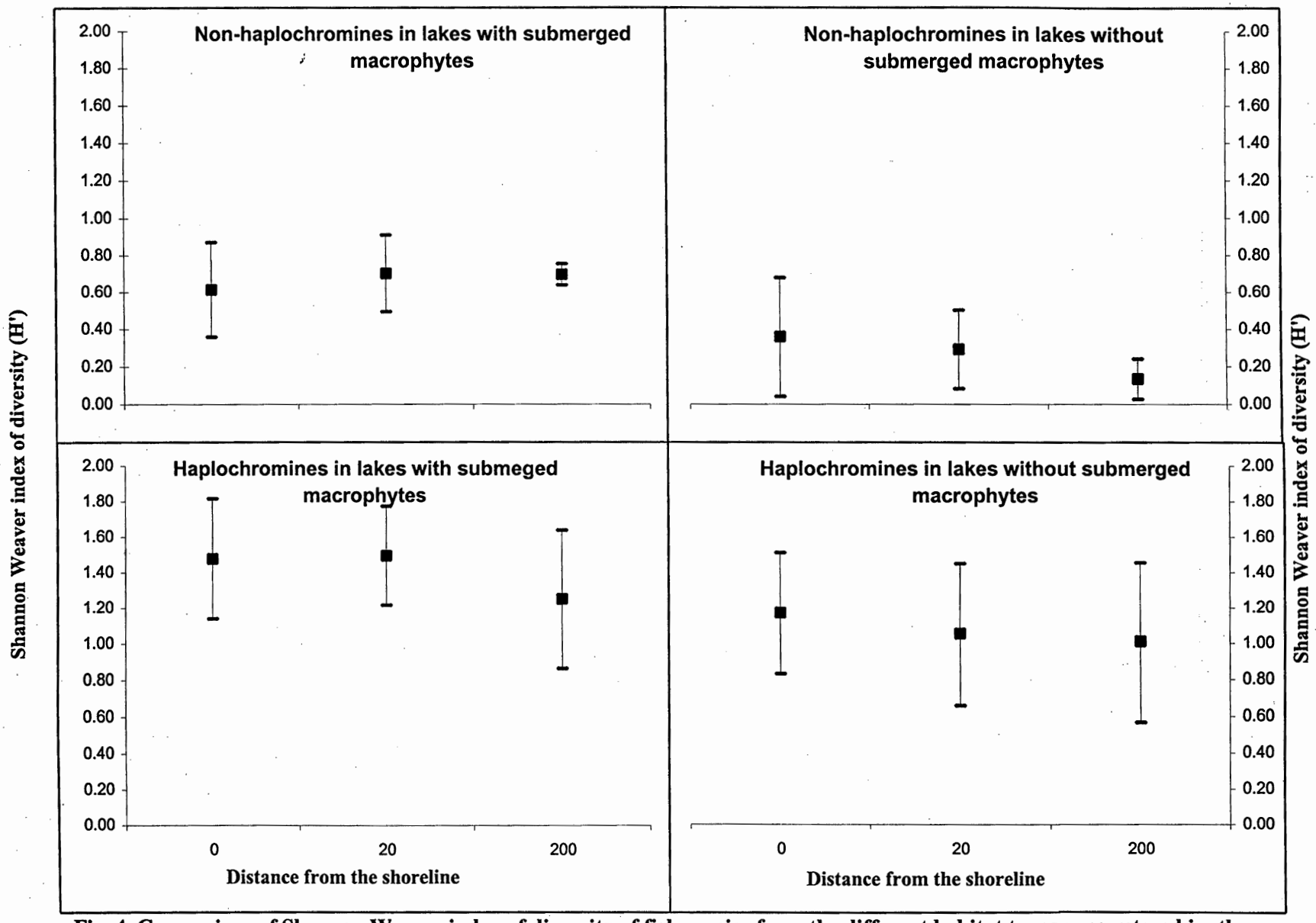

Fig. 4 Comparison of Shannon Weaver index of diversity of fish species from the different habitat types encountered in the Kyoga Minor lakes. Vertical bars represent upper and lower limits ($p<0.05$).

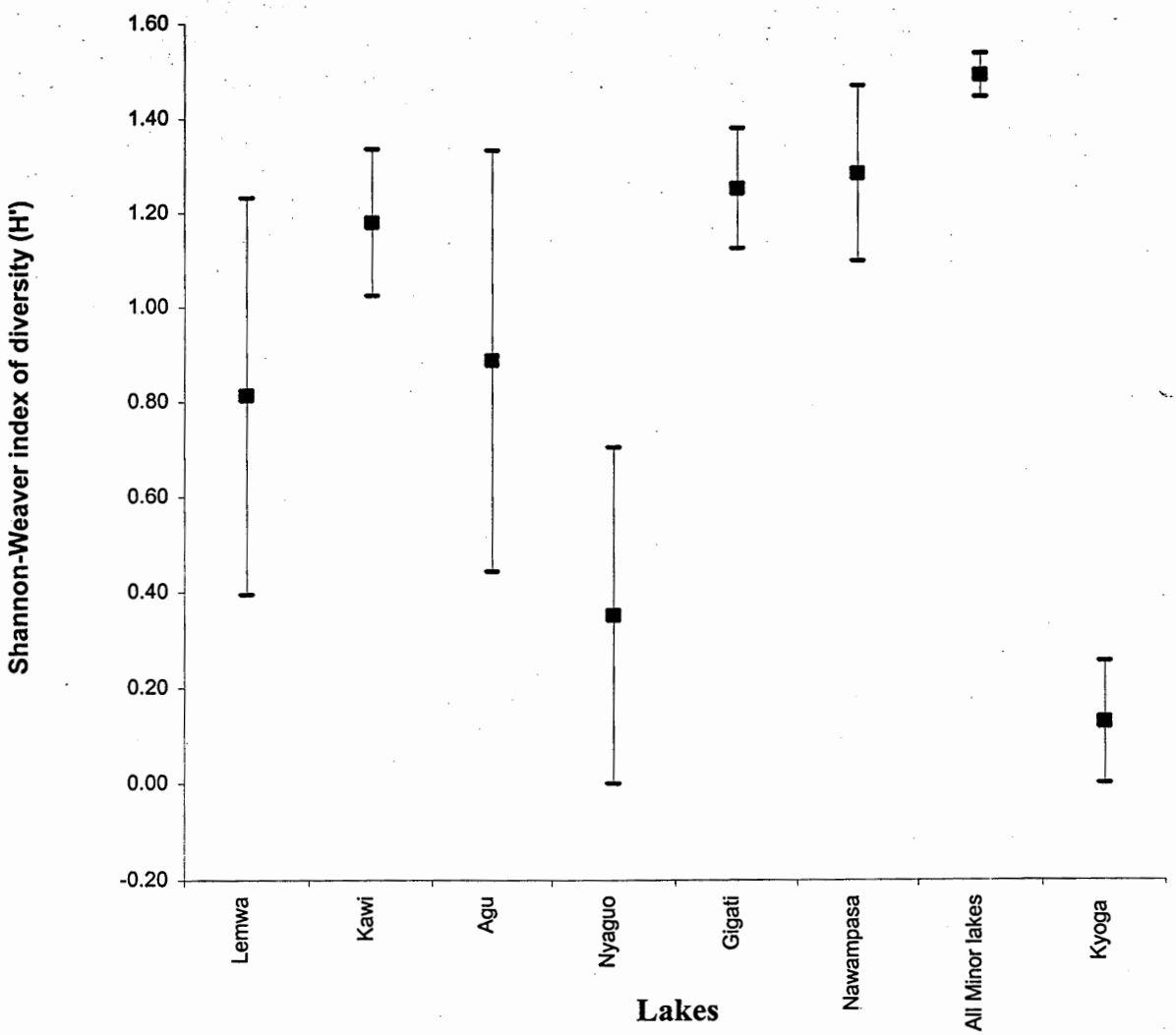

Fig. 5. Comparison of Shannon-Weaver indices of diversity of trophic goups among lakes in the Kyoga lake basin. Vertical bars represent upper and lower limits ($p<0.05$).

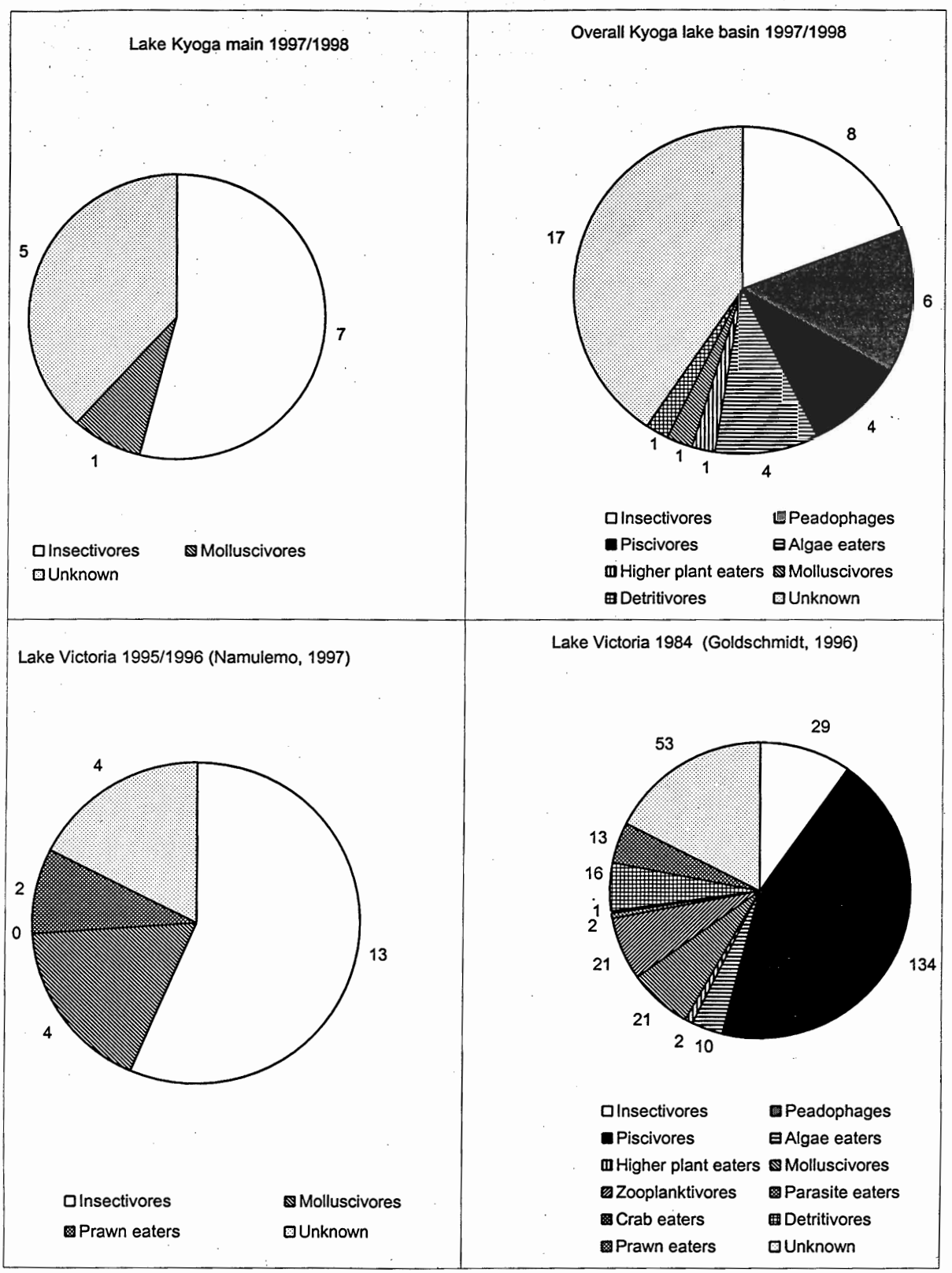

Fig. 6 Comparison of number of haplochromine trophic groups from Lake Victoria and Kyoga lake basins.