THE HISTORY AND FISHERY POTENTIAL OF KISORO MINOR LAKES

Part One: Preliminary Survey of Lakes Chahafi and Kayumbu Fisheries

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ABSTRACT

Experimental fishing using graded gill nets of varying mesh sizes, hooks and traps was conducted on Lakes Chahafi and Kayumbu during 1998 and 1999 and commercial fish catch data for period 1963 – 1998 was collected from Department of Fisheries Resources at Kabale and Entebbe headquarters. The data showed *Cyprinus carpio* (Common carp) and *Oreochromis niloticus* (Nile tilapia) as the major fisheries on Lakes Chahafi and Kayumbu respectively. However, fishery exploitation on these lakes was not continuous due to constant decline over the years even after restocking. The catch rates and size of fish that were being harvested indicated low production at the time of the study. The paper presents past trends and present status of the fishery, types of fish sizes and exploitation of the fish species in the two lakes, constraints to production and strategies for enhancing fish catches on lakes Chahafi and Kayumbu.

INTRODUCTION

The fisheries of the minor lakes in Uganda are of great importance to the population around them and presently receiving attention to enhance fish production, reduce poverty and supply fish to curb malnutrition. The fisheries also contribute to employment opportunities, incomes, and to food security and act as reservoirs of aquatic biodiversity.

There are four minor lakes in Kisoro (Fig. 1) with a total area of approximately 33.7km^2 as estimated by Uganda Lands and Survey Department Entebbe, Uganda. Two of these, Lake Chahafi (1 km^2) and Lake Kayumbu (2.2 Km^2) are close to each other near the Republic of Rwanda at an altitude of 1890 metres above sea level.

The high altitude contributes to the lakes' water temperatures being very low (14-24° C). This temperature is below the optimal temperatures for proper growth and reproduction of most fish in the tropics. Ideal temperatures have been reported as 25-30° C (Cher Vinski, 1982). *Oreochromis niloticus* however, can tolerate temperatures in the range of 14 - 42° C and in addition, 1-3mg/l of dissolved oxygen is required for the species survival though 5mg/L of dissolved oxygen is needed for proper growth. Lakes Chahafi and Kayumbu had 1.3-7mg/L and 1-11mg/l of dissolved oxygen respectively (Magumba, 2000). These two lakes have similar fish species and in the past were restocked or closed to fishing at the same time. The information available on the fisheries was mainly on past commercial catch data and the present studies carried out therefore, targeted the analysis of this data, history of commercial fishery, experimental fish species composition, distribution, relative abundance and size structure of the major fish species.

OBJECTIVES

The objectives of the study were to avail preliminary information on the fisheries of the two lakes, identify causes of low fish production and recommend ways of enhancing fish production in lakes Chahafi and Kayumbu.

MATERIALS AND METHODS

Historical information of the commercial fishery was gathered through interviews with opinion leaders, fishing communities and fisheries extension staff in the districts of Kabale and Kisoro. Commercial fish catch statistics from 1963 to 1998 were compiled from Department of Fisheries Resources at Entebbe (DFR) Uganda and District Fisheries Offices at Kabale and Kisoro. Other information was obtained from the relevant communications of the DFR with the foreign fisheries institution's staff who worked on the lakes earlier but left no publications. Experimental fishing using fleets of graded gill nets of 25.4mm to 127mm mesh size at 12.75mm intervals were conducted quarterly during 1998/1999. The fleets were set at the shoreline, 10 metres from the shoreline, and at over 30m away from the shoreline. Gill net fishing was done day and night for two days on each lake every quarter.

Hooks of size 12 to size 4 using boiled maize grains as bait were used to target *Cyprinus carpio* (Common carp). Local Kisoro traps and wire traps were set to catch fish in the shoreline vegetation. Commercial fishing boats were counted on both lakes. Gears, gear sizes and fishers' catches were examined and recorded.

The fish from experimental catches were identified for each gear and gear sizes, weighed (grammes) and their total length (centimeters) recorded. They were also sexed, assigned maturity state and where the stomachs contained food, these were removed and preserved in 5% formalin for subsequent laboratory analysis. Where the fish had eggs, these were preserved in 20% alcohol for egg count in the laboratory. The fish species which had parasites, the numbers were recorded.

RESULTS

The History of Lakes Chahafi and Kayumbu Fishery

In 1930 only *Clarias carsoni* (Nsonzi) was in the lakes being fished using local traps. The *Oreochromis niloticus* and *Cyprinus carpio* were introduced in the lakes in 1939 and 1960 respectively and were being fished using gill net mesh size nets of 101.6mm to 127.0mm. In 1960, *O. leucostictus* (Bambala) was stocked in Lake Chahafi as *O. niloticus* catches had declined. Stocking of *O. leucostictus* could have also been carried out on Lake Kayumbu but there was no record to confirm this. The fish landed then was for local consumption though some would be sold fresh or smoked in Kisoro markets. Wherever there was fish catch decline, the officials would either close the lakes to allow for recruitment or fishers would abandon fishing due to unprofitability of the fishing activities. As a result of the closure, the fish would multiply and fishing activities would resume. Though there were restocking exercises, these were irregular and few fish fry were restocked. In 1970, the otters invaded the lakes. These were also responsible for the fish catch decline as they fed on the available fish in the lakes. Hook fishing for *C. carpio* started in 1985. The highest commercial catches ever recorded for all the species was 31.6 metric tonnes (1985) and 25.2 mt (1976) on Lakes Chahafi and L. Kayumbu respectively. The lowest catches recorded were 0.3 mt (1991) on L. Chahafi and 0.5 mt (1991) on L. Kayumbu. Fish smoking was abandoned in 1980 as the catches were very low and fish was of small size in the commercial catches. There was also high demand for fresh fish on local markets due to increased population in urban centres. By 1988, the commercial catches of the major fish species (*C. carpio, O. niloticus*) were so low that by 1988-91 the fishers sought for alternative and started harvesting *C. carsoni*, and *Caridina nilotica* (Red shrimps). In 1999, *C. carsoni* and *C. nilotica* together contributed 25.1% and 30.5% on L. Chahafi and L. Kayumbu commercial catches respectively.

Commercial Catches

Analysis of commercial fish catch data on L. Chahafi and L. Kayumbu (Tables 1 & 2) and average size of fish caught (Tables 3 & 4) respectively, showed no continuous

fishing activities due to constant decline in fish catches. The fishery during 1963 – 1986 was dominated by the tilapiines and *C. carpio* as the only commercial fish species being exploited. By 1989, fishers started exploiting *C. carsoni* and *C. nilotica*. The average weight (kg) of fresh fish was in the range of 0.20-1.8kg and 0.3-4.5kg for tilapiine and *C. carpio* respectively on L. Chahafi (Table 3) and on L. Kayumbu the average size was 0.14 – 0.72 kg and 0.5 - 5.1kg for Tilapiines and *C. carpio* respectively (Table 4).

During the survey of 1998/99 very few commercial fish species were landed. *C. carpio* specimens of 2 kg average weight were occasionally caught but mainly for local markets or consumption at the landing sites.

Effort and fishing gears on lakes Chahafi and Kayumbu

Only dugout canoes were in use using gill nets of 63.5 – 101.6mm mesh size, hooks of size 8and local traps as the major fishing gears (Table 5). The hooks targeted *C. carpio,* gill nets targeted tilapiines while the traps targeted *C. carsoni* and *C. nilotica.*

Species composition in commercial and experimental catches on lakes Chahafi and Kayumbu

The observed species included: *O. niloticus, O. leucostictus, T. zillii, Barbus* sp, *C. carsoni* and *C. carpio.* Others were edible frogs (*X. kigesiensis*) and red shrimps (*Caridina nilotica*. Otters though predatory, were valued for their skin which at one time was profitable in the Democratic Republic of Congo (DRC).

O. leucostictus was caught more efficiently in the small mesh size nets of 50.8mm and below. *Barbus* sp. though of small size (4-11cm TL length) and majority mature dominated in number on L. Kayumbu.

Higher catches were recorded in gill nets of 101.6 – 127.0 mm mesh size especially for *C. carpio* on L. Chahafi (Table 6). A total of 35.7 kg of fish were recorded on L. Chahafi compared to 17.6kg on Lake Kayumbu (Table 6 & 7) during the sampling period. *C. carpio* (23. 8kg) were caught on Lake Chahafi compared to 4.5kg on Lake Kayumbu, while 7.4kg of *O. niloticus* were landed on Lake Kayumbu compared to 2.2kg on Lake Chahafi.

Fish species composition, distribution and abundance at the shoreline and offshore (over 10m) for different gill net mesh size nets are shown in Tables 8a and 8b. Based on mean catch rates (g/net/night-day), there were better catches of *O. niloticus* on L. Kayumbu both along the shoreline and offshore than on L. Chahafi. The *C. carpio* was more abundant on L. Chahafi than on L. Kayumbu both along the shoreline and off shore (Table 9).

The overall relative abundance (mean catch rates – g/day-night) by species at the shoreline compared to offshore (Table 9) indicated higher mean catch rates (136.2 g/net

per night-day) offshore on L. Chahafi contributed by mainly *C. carpio* than the shoreline (74.3 g per net per night-day) while on L. Kayumbu, the shoreline had higher mean catch rates (93.7 g per net per night) than offshore (57.3g). The overall percentage contribution by fresh weight for different fish species from (experimental gill net catches) on both lakes are shown in Fig. 2. *O. niloticus* dominated (51%) on L. Kayumbu while Common carp was the most dominant (68%) on L. Chahafi.

Experimental trap fishing

Local Kisoro traps caught mainly *C. carsoni* (31 for the entire sampling period) on L. Chahafi and 41 on L. Kayumbu, one *Barbus* sp, on L. Kayumbu, *X. kigesiensis* on L. Chahafi and one on L. Kayumbu. Only two *O. leucostictus* one from each lake along the shoreline were landed. There was no fish caught in the wire traps as the gap sizes were bigger than the Kisoro traps.

Experimental hook fishing

During the entire four quarter samples, there was one *C. carpio* caught by hook size 9 on L. Chahafi and weighed 260g while on L. Kayumbu four *C. carpio* of 1700g average weight were caught by hook size 9, one of 110 g by hook size 10. Boiled maize grains were used as bait.

Size at first maturity

Using Beverton and Holt method (1957), the size at first maturity was estimated at 26-27cm TL for *C. carpio* from L. Chahafi. All fish were mature at 34 cm TL. *O. niloticus* size at first maturity was 17-18 cm TL on Lake Kayumbu and all the fish were mature at 20 cm TL. Size at first maturity for *O. leucostictus* and *C. carsoni* on L. Chahafi was 15-16 cm TL and 12-13 cm TL respectively. *O. leucostictus* were all mature at 19 cm TL and *C. carsoni* at 16 cm TL.

Size structure of the major fish species

The size structure of fish caught from experimental gill net mesh size nets of 25.4 – 127 mm where specimens were 30 and above for frequency plots are shown in Figures 3-7. The size range for *C. carsoni* (Fig. 3) was 12-28 cm and for *O. niloticus* (Fig. 4) was 7-26 cm TL on L. Kayumbu. 93% of *O. leucostictus* caught on Lake Chahafi were below size at first maturity and had size range of 6-23 cm TL (Fig. 5). *C. carpio* size range was 10-54 cm TL and 53% of the fish were above the size at first maturity on L. Chahafi (Fig. 6). Over 95% of *Barbus* sp. from experimental gill net catches (Fig. 7) were mature (size range 4-11 cm TL) on both lakes.

BIOLOGICAL OBSERVATION

Feeding

95% of *C. carsoni* stomach contents contained chironomid larvae and pupae, the remainder contained *C. nilotica*, chaoborus larvae, povilla, odonata and detritus materials. In addition, one *C. carsoni* on Lake Chahafi had ingested a small fish. A few *C. carsoni* had molluscs and tadpoles in the stomach contents. *T. zillii, O. leucostictus* and *O. niloticus* on both lakes had macrophyte remains (99%), algae (*Nitzchia* sp, *Synedra* sp) and detritus materials in the stomach contents.

Fecundity

On Lake Chahafi, *O. niloticus* of 23 cm TL had 962 eggs and an average of 603 eggs was counted for six fish of size 22-25 cm TL from L. Kayumbu. *O. leucostictus* average egg count of 5 fish (18-23 cm TL) on Lake Chahafi was 148. *C. carsoni* on L. Chahafi had an average of 949 eggs from two fish and on Lake Kayumbu 635 eggs from 4 fish. *C. carpio* produces numerous eggs compared to the other species. An average of 204,700 eggs and 384,465 eggs were recorded for the fish from Lakes Chahafi (3 fish above 49 cm TL) and Kayumbu 2 fish above 61 cm TL respectively. *Barbus* sp. though small in size (8-10 cm TL) had an average of 449 and 883 eggs for fish from Lakes Chahafi (4 fish) and Kayumbu (11 fish) respectively.

Parasites

11% of the 220 *O. leucostictus* of size range 6-23 cm TL caught in experimental catches on Lake Chahafi were infested with nematodes.

Sex ratio (Males:Females)

The sex ratio of different fish species on Lake Chahafi and Lake Kayumbu are summarised below: Male:Female.

Species	Lake Chahafi	Lake Kayumbu
C. carpio	2.3:1	1.6:1
O. niloticus	0.7:1	1.1:1
T. zillii	1.6:1	1.5:1
O. leucostictus	1.2:1	-
C. carsoni	1.7:1	1.5:1
Barbus sp	0:16	0:41

DISCUSSION

Lakes Chahafi and Kayumbu are capable of increased and sustainable fish production if most of the constraints leading to decline in fish catches are avoided. Decline in

fisheries was due to several factors, among which is the low temperature regime of the Kisoro highlands (14 – 24°C) which causes massive mortality of fry, the excessive fishing pressure and use of small mesh size nets below 101.6 mm coupled with the predation pressure caused by numerous otters leading to constant decline in the fishery. The excessive fishing pressure led to harvesting large population of fish of low commercial value as the major fishery declined. The massive fish kills are also experienced on these lakes though not very regular. These massive fish kills had been noted earlier in the southwestern Uganda minor lakes (Green, 1976). If the nutrient status of the lakes is increased through pollution, the lakes tend to be stratified. The breakdown of stratification results into deoxygenation of epilimnion thus depriving fish of oxygen resulting into massive fish kills. Along the shoreline of these lakes, there are a lot of agricultural and grazing activities going on.

If the lakes were restocked regularly with appropriate highland fish species and appropriate density (Welcomme *et al* 1997, recommends 2-3 fry per m^2 where there has been no fish) the fishery would have been sustained. It was observed in the commercial catch records that restocking with at least 5000 fry or more of *O. niloticus*, the fishery would increase about four-fold after six months but then decline after about 3 years. Even mere closure of the fishery for one year without restocking allowed uninterrupted recruitment and improved the fishery greatly but for short period of time. Reduction of Otter predation would also enhance fish production in these lakes as these predators remove almost all the fish caught in the set gill nets.

CONCLUSION

The results presented demonstrate that lakes Chahafi and Kayumbu need regular restocking with appropriate numbers of fry able to withstand the low high altitude, temperature condition. Control of negative human impacts from the catchment into the water system and reduction of predation pressure due to otters would enhance fish production in the two lakes.

RECOMMENDATIONS

1. Introduction of permanent hatcheries, fry centers or encouraging fish farmers to produce fry in Kisoro for regular restocking of the lakes whenever catches dwindle to very low levels.
2. Reduction of predation pressure due to otters.
3. Avoiding use of destructive fishing gears and methods e.g gill net mesh size of nets below 101.6mm
4. Avoiding polluting and over-fertilizing the lakes.

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REFERENCES

Beverton, R.J.H. and S.J. Holt, 1957. On the dynamics of exploited fish populations. Ministry of Agriculture, Fisheries and Food. Fishery investigation series 11 vol. xix. Her Majesty's Stationery Office, London 533p.

Cher Vinski, 1982. In Philippine (BFAR) Freshwater Aquaculture Extension Training manual. Volume III Technology Bureau of Fisheries and Aquatic Resources UNDP 1984.

Green, J, 1976. Changes in zooplankton of Lakes Mutanda, Bunyonyi and Mulehe (Uganda Freshwater Biology 6: 433-436).

Magumba M.K., 2000, Physical-chemical algal composition and primary production in the four Kisoro minor lakes. In proceedings of the workshop on: The fisheries of Kisoro Minor lakes.

Welcomme, R.L and D.M Bartely (1997). An evaluation of present techniques for the enhancement of fisheries. FAO Fisheries Technical paper 374:1-37.

Table 1. Commercial Catch Statistics on Lake Chahafi period 1963-1998

Year	Tilapia		Common carp	Total weight
	Number	Weight (kg)	No. Wt	mt
1963	749	337	-	0.3
1964	7668	2537	few caught/not recorded	2.5
1965	12532	2804	3 - 7	2.8
1966	8572	2180	1 - 4.5	2.2
1967	7543	1828	2 - 8.0	1.8
1968	-	-	-	-
1969	-	-	-	-
1970	10899	2621	-	2.6
1971	14948	4046	-	4.1
1972	11509	3114	-	3.1
1973	1058	285	127 - 413	0.7
1974	3433	887	637- 1546	2.4
1975	2070	668	2314 - 4374	5.0
1976	2524	792	2973 - 3475	4.3
1977	4207	1232	2255 - 2749	4.0
1978	6735	1546	1590 - 1932	3.5
1979	4753	1134	763 - 700	1.8
1980	3504	759	472 - 408	1.2
1981	-	-	-	-
1982	9832	1980	4814 - 3972	6.0
1983	-	-	-	-
1984	-	-	-	-
1985	9466	16927	3373 - 14698	31.6
1986	-	-	-	-
1987	-	-	-	-
1988	-	-	-	-
	Tilapia	Common carp	*C. Carsoni* / Red shrimps	
1989		32kg (50 in number)	348kg 323kg	0.7
1990	-	-	-	
1991	216 63kg	47kg (144 in Number)	209kg -	0.3
1992	-	-	-	-
1993	-	-	-	-
	Tilapia (kg)	Common carp (kg)	*C. carsoni*/Red shrimps kg	Mt
1994	570	600	340 - 150	1.7
1995	970	1200	410 - 310	2.9
1996	1220	1130	520 - 460	3.3
1997	540	1080	510 - 330	2.4
1998	764	1469	541 - 211	3.0

Table 2. Commercial catch statistics on L. Kayumbu period 1963 - 1998

Year	Tilapia		Common carp		Red shrimps	Total weight
	Number	Weight (kg)	No.	Kg.	kg	Mt
1963		6901	-	-		6.9
1964		7064	-	-		7.1
1965		12910	4	19		12.9
1966		5957	28	142		6.1
1967		2843	-	-		2.8
1968		-	-	-		-
1969		-	-	-		-
1970	39668	14187	-	-		14.2
1971	21290	6033	-	-		6.0
1972	10645	3016	-	-		3.0
1973	11002	5549	-	-		5.6
1974	4227	925	923	2126		3.1
1975	5376	1279	6259	10440		11.7
1976	1196	864	9517	24370		25.2
1977	5370	1469	6739	13074		14.5
1978	8888	1890	3066	6889		8.7
1979	5004	1139	996	1135		2.3
1980	2497	533	635	568		1.1
1981	-	-	-	-		-
1982	7609	1724	7447	6031		7.8
1983	-	-	-	-		-
1984	-	-	-	-		-
1985	7072	3350	3358	12020		15.4
1986	1955	919	86	310		1.2
1987	-	-	-	-		-
1988	-	-	-	-		-
1989	7761	1769	1423	702	995	3.5
1990	7641	1879	486	418	745	3.0
1991	1109	152	117	213	100	0.5
1992/93	-	-	-	-	-	-
	Tilapia - kg	C.carp - kg		*C.carsoni* - kg	Red shrimps- kg	
1994	750	740		150	270	1.9
1995	960	1660		400	370	3.4
1996	2770	2530		1060	660	7.0
1997	1720	1320		800	630	4.5
1998	2223	2583		578	1529	6.9

Table 3. Average weight of Tilapia and Common carp (kg) in commercial catches on Lake Chahafi 1963-1998

Year	Tilapia	Common carp
1963	0.45	
1964	0.33	-
1965	0.22	2.3
1966	0.25	4.5
1967	0.24	4.0
1968	-	-
1969	-	-
1970	0.24	-
1971	0.27	-
1972	0.27	-
1973	0.27	3.3
1974	0.26	2.4
1975	0.32	1.9
1976	0.31	1.2
1977	0.29	1.2
1978	0.23	1.2
1979	0.24	0.9
1980	0.22	0.9
1981	-	-
1982	0.20	0.82
1983	-	-
1984	-	-
1985	1.8	4.4
1986	-	-
1987	-	-
1988	-	-
1989	-	0.6
1990	-	-
1991	0.29	0.3

Table 4. Average weight of Tilapia and Common carp (kg) in commercial catches on Lake Kayumbu (1963 – 1998)

Year	Tilapia	Common carp
1963	-	-
1964	-	-
1965	0.3	4.6
1966	-	5.1
1967	-	-
1968	-	-
1969	-	-
1970	0.35	-
1971	0.28	-
1972	0.28	-
1973	0.50	-
1974	0.22	2.3
1975	0.24	1.7
1976	0.72	2.6
1977	0.27	1.9
1978	0.21	2.3
1979	0.23	1.1
1980	0.21	0.9
1981	-	-
1982	0.23	0.81
1983	-	-
1984	-	-
1985	0.47	3.6
1986	0.47	3.6
1987	-	-
1988	-	-
1989	0.23	0.50
1990	0.25	0.90
1991	0.14	1.80
1992/93	-	-
1994/98	No data for number of fish	

Table 5. Fishing effort and fishing methods on two Kisoro Minor lakes (1999) – Chahafi and Kayumbu

Effort and fishing gears/methods	Lakes	
	Chahafi	Kayumbu
No. of fish landings	1	1
Dugout canoes (fishing)	16	46
Dugout canoes (transport)	0	5
Av. nets/canoe	2-3	2-3
Common gill net mesh size nets in mm (passive fishing)	63.5 – 101.6	63.5 - 101.6
Hooks (angling)	Size 8	Size 8
Local traps	Present	present

Table 6. Fish species composition, abundance and distribution by weight (g) from experimental gill net mesh size nets of 25.4 – 127.0mm on Lake Chahafi during 1998/99. The figures in brackets indicate percentage contribution by weight of individual fish species to the total weight of fish caught in each mesh size of gillnet.

Taxa	Mesh size (mm)									
	25.4	38.1	50.8	63.5	76.2	88.9	101.6	114.3	127.0	Total
Clarias carsoni	190 (11.6)	600 (19.6)	1010 (25.5)			75 (2.6)				1875 (5.3)
C. mossambicus			65 (1.6)							65 (0.2)
Barbus sp	747 (45.4)	28 (0.9)								775 (2.2)
O. leucostictus	530 (32.2)	2267 (74.1)	1880 (47.4)	839 (37.0)	160 (7.9)		75 (1.0)			5751 (16.1)
Tilapia zillii	80 (4.9)	70 (2.3)	665 (16.8)	165 (7.3)		225 (7.7)				1205 (3.4)
C. carpio	25 (1.5)	95 (3.1)	265 (6.7)	1165 (51.5)	1260 (62.1)	2300 (79.0)	6020 (83.8)	5660 (100)	7030 (100)	23820 (66.6)
O. niloticus	73 (4.4)		70 (1.8)	95 (4.2)	610 (30.0)	310 (10.7)	1090 (15.2)			2248 (6.3)
TOTAL	1645 (100)	3060 (100)	3955 (100)	2264 (100)	2030 (100)	2910 (100)	7185 (100)	5660 (100)	7030 (100)	35739 (100)

Table 7. Fish species composition, abundance and distribution by weight (g) from experimental gillnet mesh size nets of 25.4 – 127.0 mm on Lake Kayumbu during 1998/99. The figures in brackets indicate percentage contribution by weight (g) of individual fish species to the total weight of fish caught in each mesh size of gillnet.

Taxa	Mesh size (mm)									
	25.4	38.1	50.8	63.5	76.2	88.9	101.6	114.3	127.0	TOTAL
Clarias carsoni	265 (12.2)	815 (52.3)	1570 (48.2)	155 (5.2)	145 (4.4)					2950 (16.7)
C. mossambicus			115 (3.5)		135 (4.1)					250 (1.4)
Barbus sp	1840 (84.9)	129 (8.3)		9 (0.3)	25 (0.8)					2003 (11.4)
O. leucostictus		80 (5.1)								80 (0.5)
Tilapia zillii	15 (0.7)		285 (8.8)	145 (4.8)						445 (2.5)
C. carpio	25 (1.2)			130 (4.3)	835 (25.3)	350 (30.4)			3200 (100)	4540 (25.8)
O. niloticus	23 (1.1)	535 (34.3)	1285 (39.5)	2560 (85.4)	2160 (65.5)	800 (69.6)				7363 (41.8)
TOTAL	2168 (100)	1559 (100)	3255 (100)	2999 (100)	3300 (100)	1150 (100)			3200 (100)	17631 (100)

Table 8a. Fish species distribution (average number of fish and average weight (g) per net per night - day in experimental gillnet mesh sizes of 25.4 – 127mm set along the shoreline and offshore (>10m) on Lake Chahafi. Upper figures = average number of fish and figures in brackets = average weight in (g).

Taxa	Shoreline									Offshore								
	25.4	38.1	50.8	63.5	76.2	88.9	101.6	114.3	127 0	25.4	38.1	50.8	63.5	76.2	88.9	101 6	114. 3	127.0
C. carsoni	0.2 (3.6)	0.3 (13.2)	0..5 (46.8)							0.5 (10.0)	0.5 (20.9)	0.4 (17.0)						
Barbus spp	3.5 (30.6)	0.3 (2.3)								1.7 (14.8)	0.1 (0.8)							
O. leucostictus	0.9 (14.1)	1.6 (32.2)	0.5 (23.6)	0.1 (11.8)			0.1 (6.8)			1.7 (13.0)	4.6 (91.7)	1.7 (70.9)	0.3 (25.2)	0.1 (7.3)				
T. zillii		0.1 (1.8)	0.3 (19.5)	0.1 (8.2)		0.1 (20.5)				1.5 (11.4)	0.1 (2.3)	0.5 (20.0)	0.1 (6.4)					
Common carp		0.2 (3.6)	0.3 (13.6)	0.7 (89.5)	0.4 (76.4)	0.5 (148.2)	0.2 (77.3)		0.2 (293.6)	0.1 (1.1)	0.1 (2.5)	0.1 (5.2)	0.1 (8.2)	0.1 (19.1)	0.1 (31 8)	0.2 (235.0)	0.2 (257 .2)	0.2 (172. 7)
O. niloticus		0.1 (2.7)								0.3 (3.4)		0.1 (3.2)	0.1 (4.3)	0.1 (27.7)	0.1 (14.1)	0 1 (49.5)		
C. mossambicus												0.3 (29.5)						

Table 8b. Fish species distribution (average number of fish and average weight (g) per net per night - day in experimental gill net mesh sizes of 25.4 – 127.0 mm set along the shoreline and offshore (>10m) on Lake Kayumbu. Upper figures = average number of fish and figures in brackets = average weight in (g).

Taxa	Shoreline									Offshore								
	25.4	38.1	50.8	63.5	76.2	88.9	101.6	114.3	127.0	25.4	38.1	50.8	63.5	76.2	88.9	101.6	114.3	127.0
C. carsoni	0.4 (9.1)	0.9 (46.2)	0.9 (66.4)							0.2 (7.1)	0.7 (25.0)	0.5 (38.2)	0.1 (7.0)	0.1 (6.6)				
Barbus spp	7.1 (53.5)	0.3 (2.3)								6.0 (53.1)	0.1 (1.1)		0.1 (0.4)	0.1 (1.1)				
O. leucostictus	0.1 (0.9)										0.2 (3.6)							
T. zillii			0.3 (14.5)	0.1 (10.0)						0.1 (0.2)		0.1 (5.7)	0 1 (1.6)					
Common carp			0.7 (4.5)	0.1 (11.8)	0.3 (46.4)	0.2 (50.9)			0.1 (181.8)	0.1 (1.1)			0.1 (5.9)	0.1 (23.4)				0.1 (54.5)
O. niloticus	0.1 (0.7)	0.6 (15.9)	0.7 (45.9)	1.4 (131.8)	0.5 (81.8)	0.7 (87.3)				0.1 (0.7)	0.5 (11.8)	0.7 (35.5)	0.3 (34.5)	0.5 (48.6)	0.1 (36.4)			
C. mossambicus					0 1 (12.3)						0.1 (5.2)							

Table 9. Relative abundance (mean catch rates- g/net/night-day) by species from the shoreline compared to offshore in experimental gillnet catches of 25.4 – 127.0 mm on lakes Chahafi and Kayumbu during 1998/99.

TAXA	LAKES			
	Chahafi		Kayumbu	
	Shoreline	Offshore	Shoreline	Offshore
C. carsoni	7.3	5.4	13.5	9.3
Barbus spp	4.0	2.1	9.3	6.2
O. leucostictus	9.3	22.7	-	0.4
T. zillii	6.3	3.6	2.7	0.8
C. carpio	47.4	87.7	9.0	19.5
O. niloticus	-	11.4	57.8	20.5
C. mossambicus	-	3.3	1.4	0.6
Total (g)	74.3	136.2	93.7	57.3

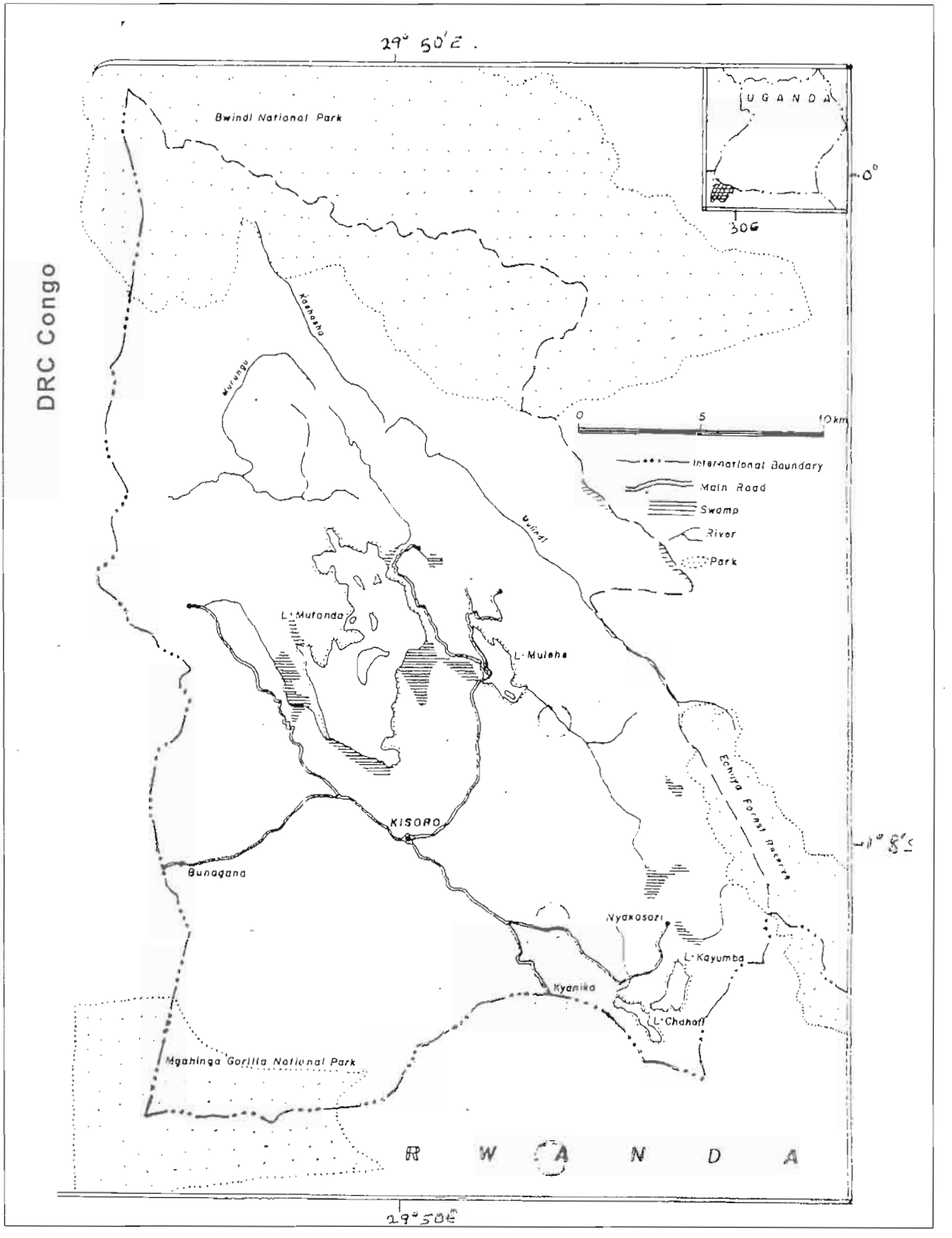

Fig. 1. Map of Kisoro showing the minor lakes

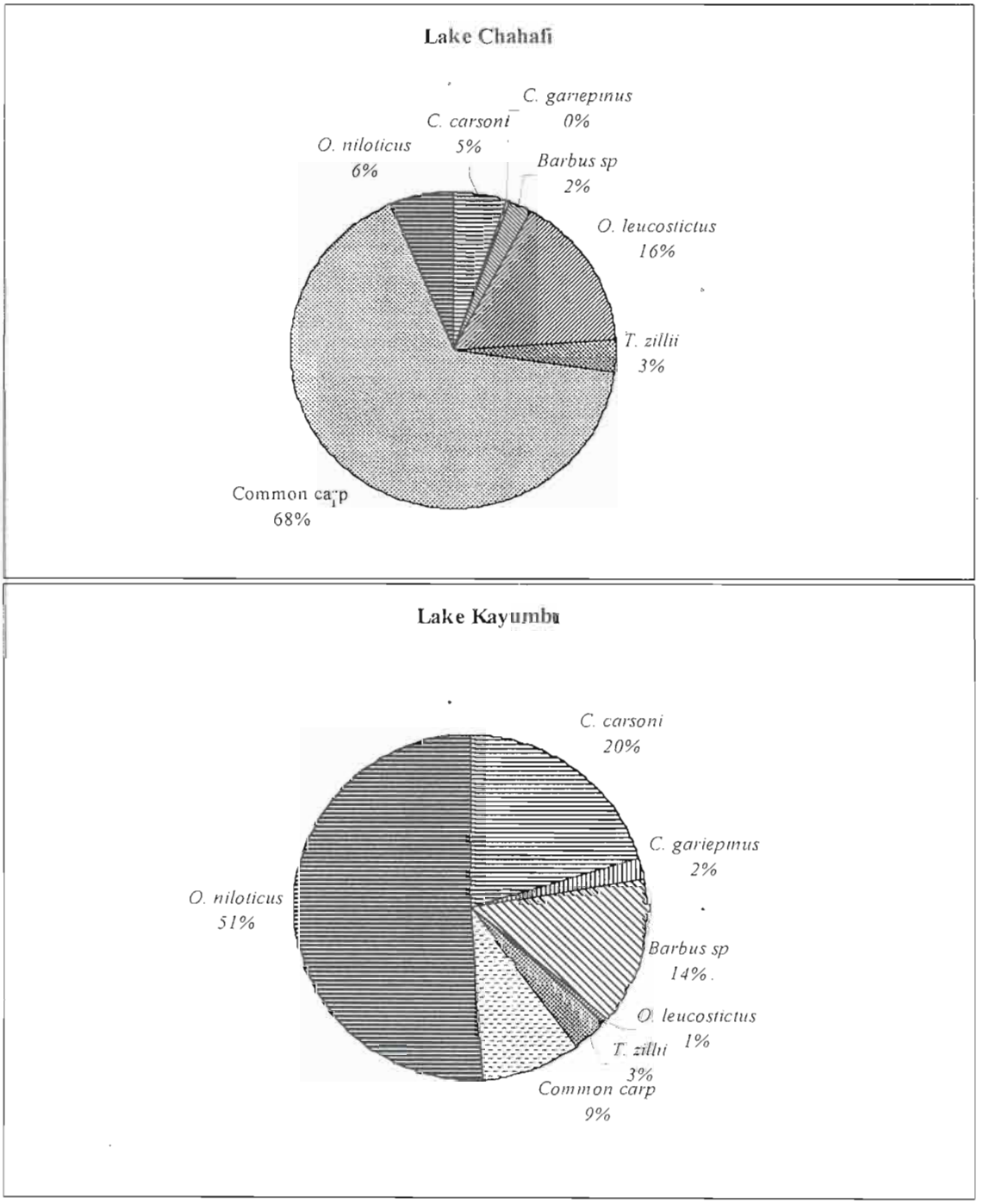

Fig. 2 .Percentage Contribution of different Fish species by Fresh weight in Experimental gill net catches of 25.4" – 127.0" mesh size on lakes Chahafi and Kayumba period 1998/9.

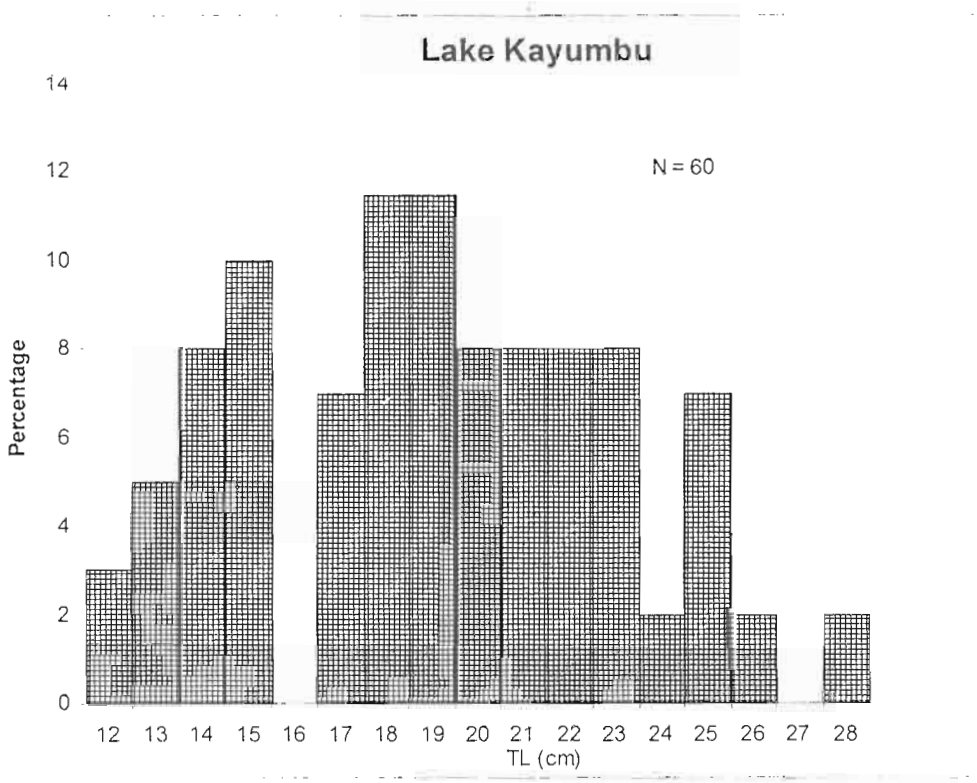

Fig. 3. Length Frequency Distribution of Nsonzi (*Clarias carsoni*) caught by experimental gillnets of 1-5"mesh size on Lake Kayumbu 1998/9

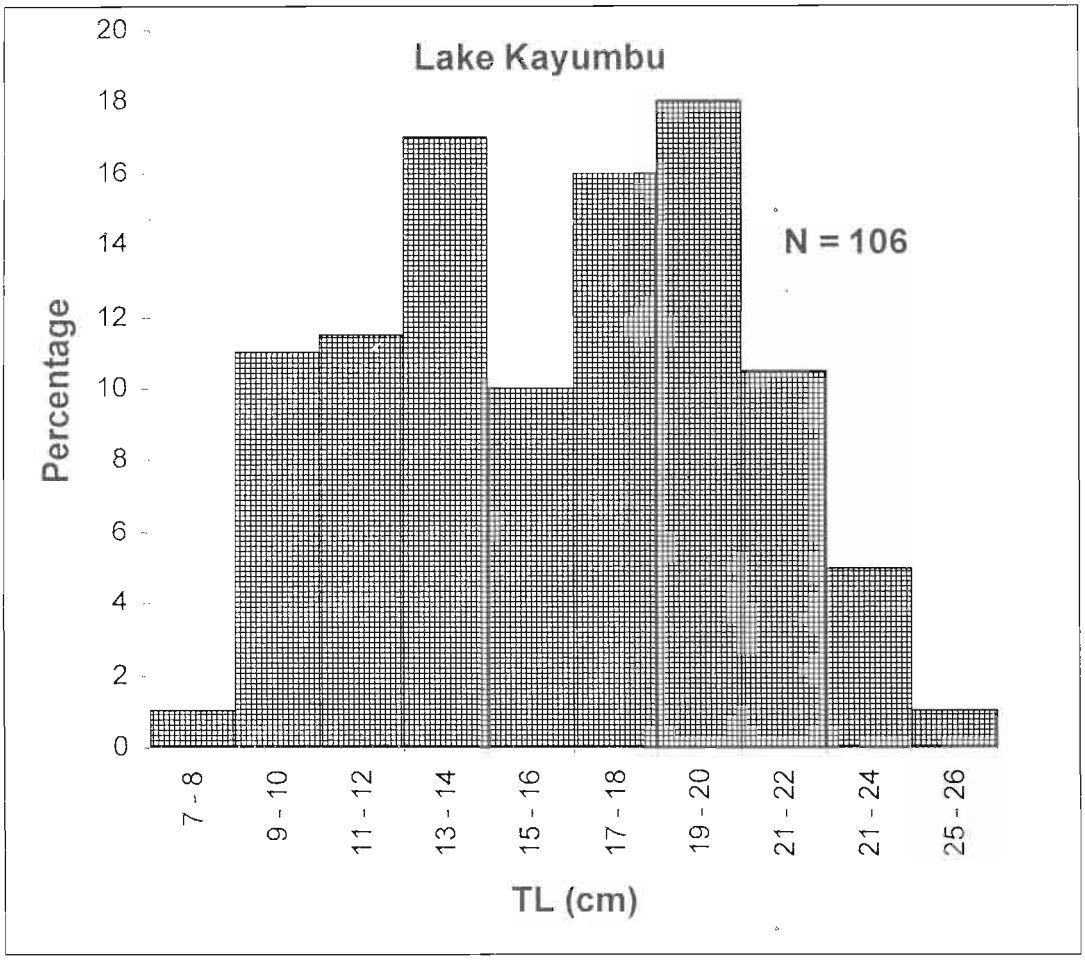

Fig. 4. Length Frequency Distribution of Nile tilapia (*Oreochromis niloticus*) on Lake Kayumbu 1998/9 using 2 cm groups. (Arrow = 50% maturity

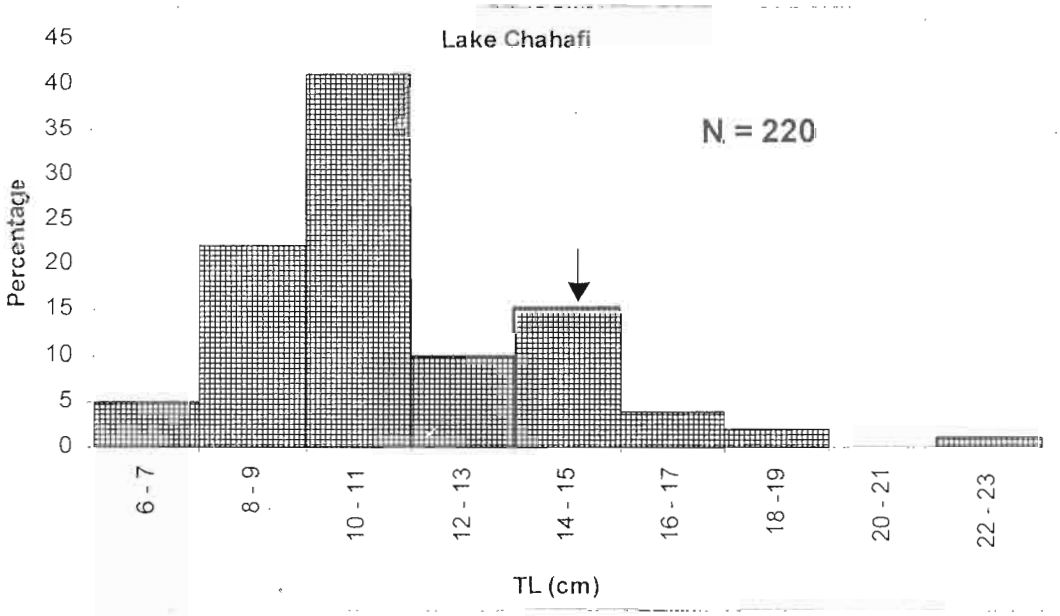

Fig. 5. Length Frequency Distribution of Bambala (*Oreochromis leucostictus*) on Lake Chahafi 1998/9 using 2 cm groups. (Arrow = 50% maturity)

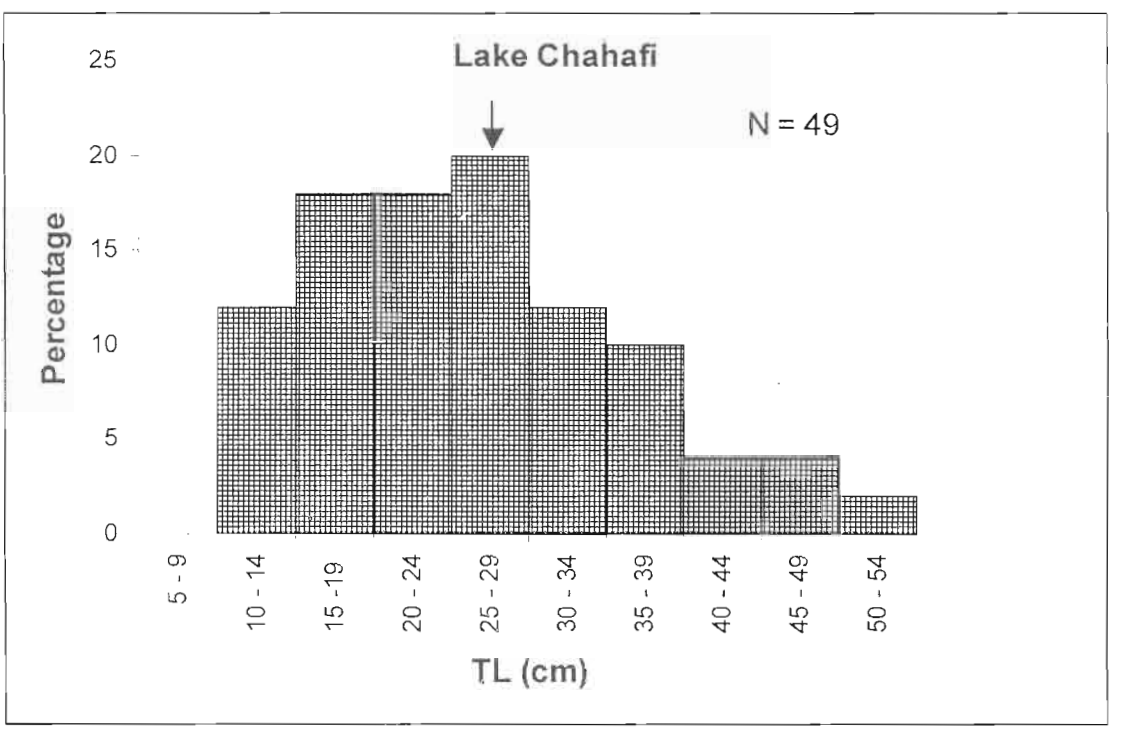

Fig. 6. Length frequency Distribution of *Cyprinus carpio* (Common carp) on Lake Chahafi 1998/99 using 5 cm groups (Arrow = 50% maturity).

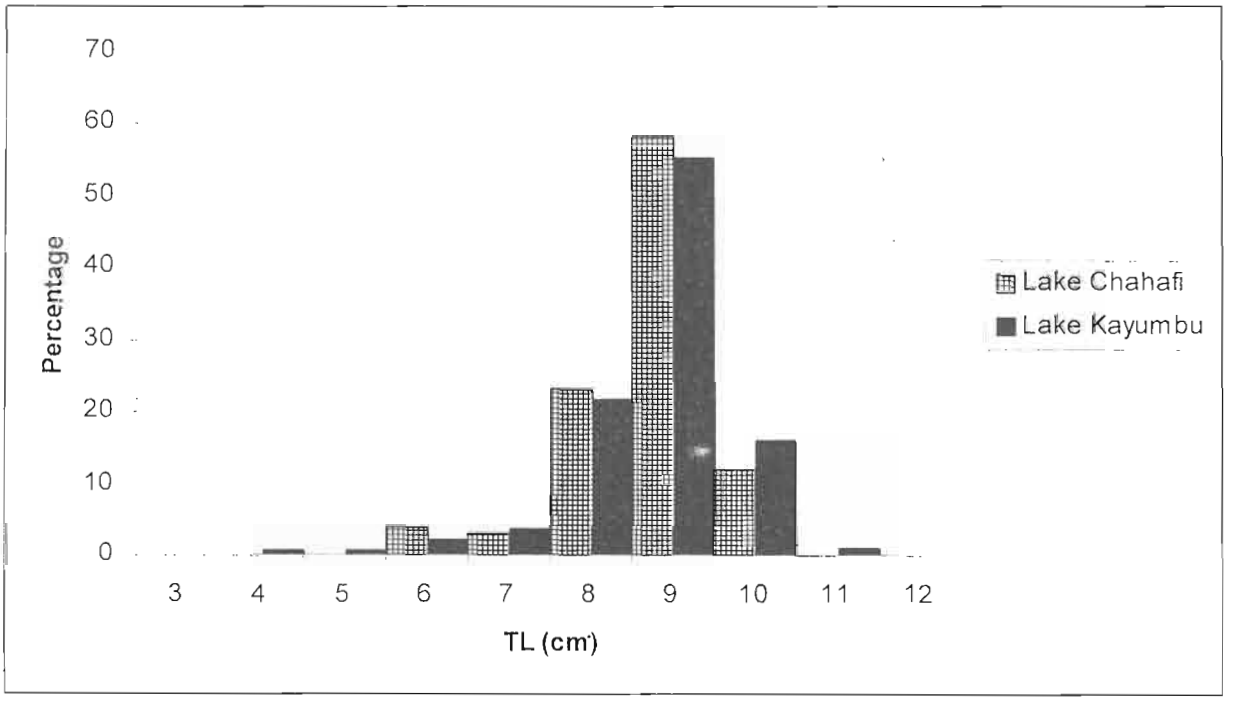

Fig. 7. Length Frequency distribution of *Barbus* sp caught by experimental gillnet mesh size nets of 1" - 1.5" on Lakes Chahafi and Kayumbu 1998/99.

