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GROWTH RATES OF JUVENILE NILE PERCH, *LATES NILOTICUS* L. IN LAKES VICTORIA, KYOGA AND NABUGABO

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Abstract

The growth rates of Nile perch, *Lates niloticus* L. of 20 cm to 40 cm total length were estimated in lakes Victoria and Kyoga in 1991 and 1992 and Nabugabo in 1992 and 1993 by tagging. Fish grew faster in Lake Kyoga (mean growth rate 28.7 ± 1.3 cm S.E. per year, N = 49) than in Lake Victoria (18.9 ± 1.4 cm per year, N = 20) and Lake Nabugabo (19.0 ± 0.7 cm per year, N = 43). There were significant differences in growth rates between the lakes ($F_{2,109} = 24.037$, $p < 0.001$). Growth rates in Lake Kyoga were significantly higher than those of lakes Victoria and Nabugabo ($p < 0.001$) but those of lakes Victoria and Nabugabo were not significantly different from each other ($p = > 0.05$). The faster growth rates in Lake Kyoga were attributed to improvement in food supply due to increases in stocks of haplochromine prey. Growth rates in Lake Kyoga were significantly higher, but those of lakes Victoria and Nabugabo were within the ranges of those reported in several native habitats of Nile perch.

INTRODUCTION

Growth among fish is affected by environmental conditions such as temperature, salinity, and food supply (BROWN 1957). However, food supply is the most important factor affecting growth rates in the tropics where water temperatures are high and vary little. Fish growth can increase or decrease according to food supply and is affected by the quantity, quality, type and size of prey (MATUSZER et al 1990, KEMPINGER & CARLINE 1977). The higher the quality of the food the faster the growth rate. Foraging efficiency also varies with type and abundance of prey. However, fish can survive for long periods with little or no food but this will lower the growth rate and affect reproduction. Growth patterns can also change with the type of prey. Changes in growth pattern following changes in prey have been observed in *Esox lucius* and *Perca fluviatilis* (HUNT & CARBINE, 1951, LE CREN, 1958). Since the rate of growth is influenced by the quality and quantity of food, it can be accelerated through improvement in food supply or retarded through its reduction (PARKER & LARKIN 1959).

Food eaten by an organism is invested into maintenance, growth and reproduction. Among immature individuals, most of the energy intake is channelled into growth and most rapid growth in length occurs before the onset of maturity (NIKOLSKY 1963). After maturity, much of the food is invested in gonadal products although most fishes continue to grow slowly after maturity. Before attainment of maturity, growth rate is closely related to food supply and varies according to the type, quality and quantity of the food (NIKOLSKY 1963). Therefore, the effects of changes in food supply on growth can be seen best before the onset of maturity.

The type, size and numbers of prey eaten by the Nile perch *Lates niloticus* L. in lakes Victoria, Kyoga and Nabugabo have changed since it was introduced and became established in these lakes (OGUTU-OHWAYO 1985, 1990, 1994, OGARI & DADZIE 1988, LIGTVOET & MKUMBO 1990). These changes may have affected growth rates of the Nile perch. In Lake Chad, growth pattern of the Nile perch changed as the predator shifted from prawns and small fish to large fish prey (HOPSON, 1972). Changes in the abundance of clupeid prey have also been associated with changes in growth rate of *Lates mariae* in Lake Tanganyika (COULTER 1976). This study was partly intended to show how the changes

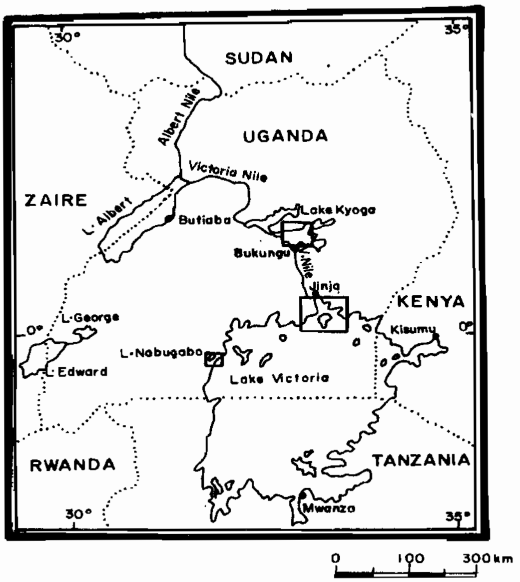

Fig.1 The map of uganda showing the location of lake victoria, Kyoga and Nabugabo. The areas where fish were tagged in each lake are indicated by a rectangle.

in the type, size and numbers of prey eaten may have affected growth rate of the Nile perch in the new habitats and how the situation in the habitats invaded by the Nile perch compared with that in native habitats where Nile perch has remained in balance with its prey for a long time.

There are virtually no historical data upon which comparisons of changes in growth rate of Nile perch in lakes Victoria, Kyoga and Nabugabo can be based. ACERE (1985) and ASILA and OGARI (1987) estimated growth rates of Nile perch only in Lake Victoria and their data suggest that originally, both here and probably in other non-native habitats growth rates were higher than in native habitats (JENSEN 1957, HOPSON 1972). At that time, haplochromines were the most abundant fish in Lake Victoria (KUDHONGANIA AND CORDONE 1974) and formed the main prey of the Nile perch (GEE 1969, HAMBLYN 1966). These were rapidly depleted by Nile perch predation following rapid increases in its stocks (OGUTU-OHWAYO 1985, 1990, 1994, OGARI & DADZIE 1988, LIGTVOET AND MKUMBO 1990) after which the predator shifted to other probably less profitable prey. Haplochromine populations have recently increased and become more important as prey in Lake Kyoga (OGUTU-OHWAYO 1994). This change in the type of prey can be manifested in growth rate of the predator in Lake Kyoga as compared to lakes Victoria and Nabugabo and may give an idea of how fast the predator grew when haplochromines were still abundant and whether depletion in haplochromines may have resulted in reduction in growth rate of Nile perch.

Unlike in temperate regions, estimation of age and growth of fish in the tropics using growth marks on bony structures is often difficult due to lack of distinct checks and a means of interpreting them where they do occur. Because of this, previous attempts to estimate growth parameters of Nile perch in Lake Victoria were based on modal length progression analysis (ACERE 1985, ASILA & OGARI 1987) and to a limited degree on tagging (LIGTVOET & MKUMBO 1990). There are, however problems of estimating age and growth of long-lived species like Nile perch from modal length progression analysis because length frequency analyses become unreliable when the distributions merge or overlap following changes in growth rate (BEAMISH & MACFARLANE 1987). Modal length progression analyses are thought to be unsuitable for ageing Nile perch (HOPSON 1972). The data presented here should, therefore, be useful in estimation of age and growth of the Nile perch and for comparison with previous results which were based on other methods.

Growth rates of Nile perch in lakes Victoria, Kyoga and Nabugabo were examined and compared. The hypotheses tested were that (1) there were no significant differences in growth rates of Nile perch between the three lakes and (2) the growth rates in these lakes were not significantly different from those in habitats where Nile perch occurs naturally.

MATERIALS AND METHODS

Growth rates of Nile perch were estimated by tagging. On Lake Victoria, fish were tagged in the northern region of the lake near Jinja, on Lake Kyoga fish were tagged around Bukungu and on Lake Nabugabo. In lakes Kyoga and Nabugabo, the fish were caught in seines and in Lake Victoria by trawling in shallow waters. Fish trawled from deep waters appeared fatigued and some had everted stomachs apparently due to expansion of the gas bladder following rapid changes in depth. Live fish were placed in tanks and transported to the place of release. The total length of the fish was measured to the nearest 0.1 cm, the number on the tag was recorded, the tag was injected in the dorsal musculature using a tagging gun and the fish released. The site of capture and that of release were also recorded.

Tagged fish on lakes Victoria and Kyoga were recovered by commercial fishermen but those in Lake Nabugabo were recovered in experimental seines and wherever possible measured and released again. Advertisements for report of tagged fish were made verbally at fish landings, by posters placed at different places, and in radio broadcasts. Fishermen were requested to pass to the nearest fisheries official or bring to the Fisheries Research Institute either the tagged fish or a stick equal to the total length of the fish plus information on the date and place of capture. A reward which included a refund of transport costs incurred was to be given. Initially, some fishermen who recovered fish below legal size (46 cm) tended to bring sticks longer than the fish they had recovered for fear of being prosecuted. This problem was overcome by requesting the fishermen, who could not bring the fish fresh, to gut and sun dry it without removing the tag and later bring it together with the stick to our laboratory to facilitate comparison with the stick. It is the measurement on the stick which were recorded, dry fish were only used to verify whether the length of the stick had been a fair estimate of that of the fish.

Growth rates were estimated for fishes tagged in lakes Victoria and Kyoga in 1991 and 1992 and in Lake Nabugabo in 1992 and 1993. In order to make the data comparable between the lakes, fishes of the same length range were tagged during approximately the same time of the year. A total of 1842 Nile perch were tagged on Lake Victoria, 1766 on Lake Kyoga and 700 on Lake Nabugabo. Most were within the 20 to 60 cm length class. Most of these would, according to previous results of HOPSON (1972), JENSEN (1957) and ACERE (1985) be in their first year of life. These were mainly immature individuals but also represented the size range just before recruitment into the harvestable stock. The data therefore gave an idea of how fast the Nile perch grew before it matured and was recruited into the fishery.

Growth rates were estimated using the equation:

$$GR = \frac{(L_2 - l_1)}{D} \times 365$$

Where GR = annual growth increment in cm, L_1 = total length in cm at release, L_2 = total length in cm at recapture and D = number of days between release and recapture.

RESULTS AND DISCUSSION

One hundred and ten tagged fish were recovered on Lake Kyoga, 27 on Lake Victoria and 43 on Lake Nabugabo. Comparisons of growth rate between lakes were confined to Nile perch of 20 to 40 cm because most of the fish recovered on the three lakes were within this size range. This also reduced the effect of maturity on growth rate because many fish especially males start maturing after about this size (HOLDEN 1963, HOPSON 1972, 1982, OGUTU-OHWAYO 1988, 1994). Also, in order to minimize errors due to inaccurate measurements on the stick only measurements made on actual fish were used in comparison of growth rates.

Table 1. Growth rate of 20 cm to 40 cm total length in lakes Victoria, Kyoga and Nabugabo and that recorded in two native habitats, lakes Mariout and Chad.

Lake and period		Parameter		
Non-native habitats:		Mean	2SE	N
Victoria	1991 - 92	19.8	1.3	20
Nabugabo	1992 - 93	19.0	0.7	43
Kyoga	1991 - 93	28.7	1.3	49
Native habitats:				
Chad		21.1		
Mariout (range)		21.7		

Mean annual growth rates of Nile perch for each of the three lakes are given in Table 1. Nile perch grew faster in Lake Kyoga than in Lake Victoria and Lake Nabugabo. ANOVA showed that there were significant differences in growth rates between lakes ($F_{2,109}$ = 24.037, $p < 0.001$). A multiple comparison of means test between the lakes showed that growth rates in Lake Kyoga were significantly higher than those of lakes Victoria and Nabugabo ($p < 0.05$) but those of lakes Victoria and Nabugabo were not significantly different ($p > 0.05$). *L. niloticus* attained a length of 19.5 cm to 23.9 cm at the end of the first year in Lake Mariout (JENSEN 1957) and a mean length of 21.1 cm in Lake Chad (HOPSON 1972). The growth rate of *L. niloticus* in lakes Victoria and Nabugabo are similar to that in Lake Chad and Mariout but those for Lake Kyoga are higher.

The size at first maturity of Nile perch in lakes Victoria, Kyoga and Nabugabo at the time that these records were made was similar (OGUTU-OHWAYO 1994). Faster growth rate of Nile perch in Lake Kyoga as compared with lakes Victoria and Nabugabo could be explained in terms of differences in the type and size of prey eaten. Haplochromines were the most important and preferred prey of Nile perch in lakes Victoria, Kyoga and apparently Nabugabo, soon after its establishment (HAMBLYN 1966, GEE 1969, OKEDI 1971, OGUTU-OHWAYO 1993). The predator only shifted to other prey comprising *Caridina nilotica, Rastrineobola argentea*, Nile perch juveniles and tilapiines after haplochromines had been depleted (OGUTU-OHWAYO 1990, 1994). At the time of the tagging, stocks of haplochromines had increased and again become important as prey of Nile perch in Lake Kyoga (OGUTU-OHWAYO 1994). This may have improved the quality and quantity of available food and reduced the amount of energy expended by the Nile perch in collecting the food. WANINK & GOUDSWAARD (1994) have shown that for a given length of prey, the Nile perch obtains more food (by weight) by feeding on specific numbers of haplochromines than by feeding on equal numbers of *R. argentea* mainly because of size differences. After the initial depletion in haplochromines, *R. argentea* became the main prey of Nile perch in the new habitats and were still the main fish prey of the size range for which growth rates were compared in lakes Victoria and Nabugabo. The average size of haplochromines is much higher than that of *R. argentea*. Nile perch probably expend more energy collecting enough *R. argentea* as prey than when hunting haplochromines because of size difference.

The current mean growth rates of Nile perch in lakes Victoria and Nabugabo are close to the mean values reported for several native habitats of Nile perch (Table 1). The higher values recorded for Lake Kyoga suggest that Nile perch has the capacity to adjust its growth rate as food supply changes and apparently grew faster when haplochromines were still abundant in the new habitats.

ACERE (1985) estimated the growth rate of Nile perch in Lake Victoria using data collected when haplochromines were still its main prey and suggested that at that time, it attained a mean total length of 52 cm at the end of the first year of life. This value is much higher than the current estimates for Lake Victoria and other non-native habitats. HUGHES (1992) has questioned the accuracy of ACERE'S estimates because he pooled length frequency data collected over many years without taking into account the time of the year that the fish were collected, which invalidates use of length frequency analysis. Most of ACERE'S specimens also came from gill net catches which due to their selectivity can give biased estimates using modal length progression analysis.

HUGHES (1992) estimated growth rate of Nile perch in the Nyanza Gulf of Lake Victoria in 1983 and recorded growth of 23 cm total length in 287 days. This indicates that the fish achieved a length of about 29 cm by the end of the first year of life. This value, which corresponds to the period when haplochromines were just disappearing from the Nyanza Gulf, is comparable to the current estimates for Lake Kyoga.

There were no growth estimates for Lake Albert. However, if the values for lakes Mariout and Chad are representative of native habitats, then the current growth rates of immature Nile perch in lakes Victoria and Nabugabo are comparable to those in native habitats. The prediction that growth rate of the Nile perch in the new habitats has attained a level which is not different from that of native habitats can be accepted in respect to lakes Victoria and Nabugabo. The currently higher values for Lake Kyoga seem to be due to the recent increases in haplochromine prey.

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