The evolution of the fishery of Oreochromis niloticus (Pisces: Cichlidae) in Lake Victoria.

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Prepared for:

The annual symposium of the Hydrobiological Society of Eastern Africa (HYSEA) on "The State of knowledge and recent research advances in freshwater and marine biology in East Africa".

Nairobi, Kenya, 13-16 December, 1988

A B S T R A C T

The Lake Victoria ecosystem has experienced changes associated with fishing levels, a rise in lake level of the 1960s, fish introductions, and human activities in the drainage basin. Following the fish introductions of the 1950s and early 1960s, Oreochromis niloticus has become the most abundant and commercially important species among the tilapiines. It appears to be the only species which has managed to co-exist with the Nile perch not only in Lake Victoria but also in Lake Kyoga where the two species were also introduced. There is, however, little published information on the biology and ecology of the species in the new habitats. It has therefore been found necessary to initiate studies as have been developed for Lates niloticus, especially as the two species have assumed a major role in the lake's fisheries. This paper is a preliminary assessment of some characteristics of O. niloticus in Lake Victoria.

INTRODUCTION

Oreochromis niloticus LINNE' (previous taxa: Tilapia nilotica/ Sarotherodon niloticus) is a cichlid of the tilapiine group (Trewavas, 1983). The species is presently common in many parts of the world. It occurs together with S. galilaeus Linne' and T. zillii Gervais throughout much of its natural range in Palestine, in the Nile and across to West Africa, and in Lakes Rudolf (Turkana) and Albert in East Africa (Lowe-McConnell, 1958). The natural distribution of O. niloticus is given by Trewavas (1983) as The Yorkon river near Tel Aviv; the Nile; Jebel Marra; Lake Chad basin; Niger system; Volta River; Gambia River; Senegal River; Lakes Albert, Edward, Kivu, and the shallower parts of Lake Tanganyika; Lake Tana and the other Ethiopian lakes, Ergino river (Omo system), Lake Turkana (Rudolf), Suguta river and Lake Baringo. She recognizes seven subspecies including Oreochromis niloticus eduardianus one of the tilapiines stocked in various waters in Uganda.

Following its introduction in Uganda from the early 1950s, O. niloticus has become the most abundant and commercially the most important tilapiine from Lake Victoria north and it contrasts sharply with the tilapia of the 1950s and 1960s which were O. esculentus and O. variabilis. The mainstay of the commercial fishery of both Lakes Victoria and Kyoga are Oreochromis niloticus and Lates niloticus, (The Nile perch) - another introduced species (Ogutu-Dhwayo, 1984; 1988; Acere, 1988). From the mid seventies to present, the two species comprise on average 60% of the catch at Masese (Lake Victoria north) (Table I). However, while L. niloticus has received much attention in the past due to its impact on the lake fishery (Ogutu-Dhwayo, 1984, 1988; Acere, 1985, 1988; Ogari, 1984; Okarionon et al 1984; Ssentongo & Welcomme, 1985; Hughes, 1986; Goudswaard & Ligtvoet, 1988) there is little published information on O. niloticus in the new habitats especially in Lake Victoria. This paper is a preliminary assessment of O. niloticus fisheries in northern waters of the Lake.

THE INTRODUCTION OF O. NILOTICUS IN LAKE VICTORIA

The exact date of first introduction of O. niloticus into Lake Victoria is probably unknown but it occurred in the early 1950s. Welcomme (1966a, b; 1967) reports that O. niloticus was stocked into Kagera river (Uganda part) in 1954 via the Koki lakes which had been stocked in 1936 from Lake Bunyonyi. The origin of these stockings was Lake Edward. The species was reported from the new habitat in the same year of the Kagera stocking. There followed further stockings of Lake Victoria in Kenya and Tanzania waters between 1956 and 1958 with fry from Kajjansi Fish Ponds. More stockings of Lake Victoria were carried out from Entebbe (Uganda) between 1961 and 1962. The latter stockings were massive involving tens of thousands of fry whose origin is not well documented but were probably from Lake

Albert via other areas such as Kajjansi and dams of Eastern Uganda (Lowe-McConnell, 1958; Welcomme, 1966b; 1967). The Lakes Albert-Edward origin of *O. niloticus* represents *O. niloticus eduardianus* (Trewavas, 1983).

Apart from *Oreochromis niloticus*, other tilapiines introduced into Lake Victoria between 1951 and 1962 were *O. leucostictus*, *T. zillii* and *S. melanotheron* (= *I. rendalli*) - the last originating from Zambia. The picture of introductions is somewhat confused as Trewavas (1983) suggests that *O. leucostictus* came originally by accident with *T. zillii* from Lake Albert. She also points out that the lake was stocked with the Lake Turkana subspecies of *O. niloticus* (= *O. niloticus vulcani*).

PAST TRENDS IN THE TILAPIA FISHERY OF LAKE VICTORIA

The history of the fishing industry on Lake Victoria up to the mid-sixties was given by Mann (1969). Even in absence of catch records, there was virtually no impact on the stocks by subsistence requirements up to the 1900s when gill-nets were introduced as a new fishing technique. Lake Victoria then contained accumulated stocks of *Oreochromis esculentus* and was described by early explorers as a tilapia lake. With the introduction of the gill-net, coupled with the growth of urban centres and communications around the lake, the fishing industry assumed a commercial role. By 1916, the catch rate per net per night (c.p.n) ranged from 25 to 100 *O. esculentus* in a 5 inch (127 mm) net of 50 yards (C. 45 m) (EAFRO, 1955/56). The gill-nets were so obviously popular that the fishing effort increased to the extent that by the mid - 1920s, the number of tilapia (essentially *O. esculentus*) had declined to 5 (c.p.n.) in Nyanza Gulf and 4-7 elsewhere (EAFRO 1954/55; Mann, 1969).

Following a survey of the Lake Victoria fisheries, Graham (1929) recommended a mesh size limit of 5 inches (127 mm) to protect *O. esculentus*, and a lake wide authority responsible for fishery regulation and catch-data collection. These were initiated in 1933 and the Lake Victoria Fisheries Service was established in 1947 (Mann, 1969). In spite of these measures and the economic depression following the world war, the catch per net per night of *O. esculentus* dropped from 3.1 between 1933-37 to 1.9 by 1945 and 1.2 in 1955 (Mann, op. cit.). As *O. esculentus* was marketed by numbers rather than by weight, the absence of a price differential between small and large fish encouraged fishermen to fish with undersized gill-nets for which there were no import and sales restrictions. Thus, from 1956 there appeared in the fishery gill nets of 4.5 inch (114 mm) mesh. This resulted in a considerable increase in profits to the fishermen and, with these nets catches of *O. esculentus* were restored.

The smaller meshed-nets of 3" to 4.5" became widespread in the late 50s and early 60s. These nets mainly captured stocks of *Oreochromis variabilis* which had been shown to grow to a smaller size and have a lower growth rate than *O. esculentus* (EAFRO,

1958/59). With increased fishing effort, Q. variabilis declined over a relatively shorter period than did Q. esculentus. A compensatory factor was the appearance of the introduced Q. leucostictus and I. zillii though Q. variabilis still dominated the commercial catch in 1962 (EAFFRO, 1965).

The period 1961-1963 was characterised by exceptionally heavy rains which led to a rise in the water level of Lake Victoria. The effects of this rise were the flooding of the marginal areas of the lake and the creation of new beaches and lagoons, leading to improvements in tilapia stocks (Welcomme, 1965). All the tilapiines (both endemic and introduced species) featured in commercial catches.

THE GROWTH OF THE FISHERY FOR Q. NILOTICUS

Oreochromis niloticus appeared in the commercial records for the first time in 1960 (Welcomme, 1967). Since the species grows to a large size, the stocking of the species in Lake Victoria in the 1950s and 1960s had been expected to lead to a return of the use of the 5-inch (127 mm) mesh gill nets and, to increase the commercial fishery. However, this objective had not been fulfilled by 1963 and the species constituted less than 1 per cent of the commercial catch (Welcomme, 1965). However, from 1965 on, the species started featuring prominently in the commercial catches. There were varying degrees of prominence reflecting the geographical location of fishing ground and approximate period of stocking (Table 2). It appears that the species first established itself to the west of the lake followed by an eastward trend towards Entebbe. From Tables 1 and 2, it is clear that from the late 1960s up to present, Q. niloticus has assumed a major role in the commercial fishery of Lake Victoria and has encouraged a return to the use of the 5-inch gill net.

FACTORS FAVOURING THE GROWTH OF THE Q. NILOTICUS FISHERY OF LAKE VICTORIA

The massive 1960s stockings off Entebbe followed by the rising lake levels could have enhanced the further spread of Q. niloticus especially with the appearance of new breeding areas. An additional factor favouring Q. niloticus was the reduced competition for space by the reduced levels of the endemic Q. esculentus and Q. variabilis.

Overfishing with increased use of small mesh gill nets of 3" to 4.5" (76-114 mm), and unrestricted use of beach seines in some areas reduced population levels of Q. esculentus and Q. variabilis. The introduced Q. leucostictus and I. zillii made a temporary impact but were also apparently overfished in the early sixties. With a reduction in the tilapia stocks of the above species, Q. niloticus could have firmly established itself especially after the rise in lake level. One factor favouring an increase of Q. niloticus could have been the reduced level of competition for breeding habitats.

In a study of the biology and ecology of O. niloticus in East African lakes, Lowe-McConnell (1958; 1959) noted that the species has a wider plasticity in growth and ecological tolerance than the other tilapiines. The ecological and limnological changes which have occurred in the lake could not suppress the successful colonization of the lake by O. niloticus. This success is partly reflected by Welcomme's (1967) prediction that a fall in lake level would result in a reduction of nursery areas and O. niloticus would eventually occupy a more important position. The inshore zone of Lake Victoria has been influenced by human activity in the drainage basin (Bugenyi and Balirwa, 1988). Examples of this impact are the widespread clearance of swamp and marginal vegetation as well as nutrients transported to the lake via run-offs. The effect of swamp clearance could have been an increase in spawning areas for O. niloticus. On the other hand, the disappearance of water lillies and other aquatic weeds effectively reduced the nursery grounds for O. esculentus, and, the feeding niche of higher plant material (Potamogeton and Ceratophyllum) which are ingested by T. zillii (Welcomme, 1967).

Welcomme (1967) observed that in Lake Victoria, O. niloticus feeds on planktonic material of both plankton and bottom deposits (i.e planktonic rain of debris). Preliminary studies in progress suggest that the Lake Victoria O. niloticus is best described as an opportunistic omnivore, and, availability is a key factor in the feeding habits of the species. The food ingested consists of a broad spectrum of items including detritus, crustaceans, mollusc eggs and insect material. Flagellates and Rotifers, at least 16 species of phytoplankton generally associated with detritus, have all been found in gut analyses. The feeding habits of O. niloticus in Lake Victoria are therefore probably of higher survival value than those of other tilapiines. The success of O. niloticus in colonizing Lake Victoria has partly been due to its omnivorous diet which includes detritus, and, to the probable increase in the fertility of the lake after the heavy rains of the early 1960.

Following the establishment of the Nile perch (Lates niloticus) in Lake Victoria, there has been an obvious reduction in ichthyofaunal diversity (Ogutu-Ohwayo, 1984; Ogari, 1984; Hughes, 1986; Goudswaard, 1987). The apparent magnitude of this factor is likely to have promoted the spread of O. niloticus into various vacant ecological niches due to its reported wide ecological tolerance. In the presence of Nile perch, it is now the species (apart from Rastrineobola argentea) which has managed to co-exist with the former. This apparent co-existence with L. niloticus in both the endemic and introduced habitats may be due to ecological separation which has evolved over a long time.

Tilapias are known to interbreed under both natural and artificial conditions (Lowe-McConnell, 1958, 1959; Elder and Garrod, 1961; Elder et al, 1971; Welcomme, 1967). From such studies, Welcomme (op cit) reported two naturally occurring

hybrids - S. melanotheron x I. zillii and O. variabilis x O. niloticus hybrids while O. esculentus x O. niloticus were observed under experimental conditions (Lowe-McConnell, 1958). On the basis of preliminary studies in the northern waters of Lake Victoria, it is apparent that such hybrids are now common. A characteristic feature of all these hybrids is the dominance of O. niloticus morphological features. Therefore for all practical purposes, the most common tilapia in Lake Victoria north at present is some form of O. niloticus.

ACKNOWLEDGEMENTS

I wish to thank The Director of UFFRO for encouragement and facilities to initiate research on Oreochromis in Lake Victoria; the Regional fisheries officer at Jinja for commercial catch data; Mr. Ogutu-Ogwayo and the IDRC group for collaborative work on the Nile perch and Nile tilapia; Elsie Twongo and Bob Amiina for assistance in field and laboratory analyses; other staff of UFFRO for advice and help, and Ferry for typing the manuscript.

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Table.1

FISH PRODUCTION BY SPECIES FOR SOME YEARS AT MASESE LANDING

SPECIES	1974	1976	1977	1981	1982	1983	1984	1985	1986	1987
<u>Oreochromis niloticus</u>	34.2	38.8	38.2	37.0	50.6	55.2	18.1	42.5	22.9	37.8
<u>Lates niloticus</u>	26.7	20.1	3.4	34.8	30.7	41.0	71.4	44.6	69.9	59.8
<u>Tilapia zilli</u>	1.3	0.2	0.2	0.6	2.1	0.5	5.9	5.4	5.2	0.1
<u>Oreochromis leucostictus</u>	1.6	1.5	0.9	1.2	0.3	0.1	0.4	0.4	0.1	-
<u>Oreochromis esculentus</u>	0.01	0.01	0.01	-	-	-	-	-	-	-
<u>Oreochromis variabilis</u>	3.6	8.8	15.7	15.2	-	-	-	-	-	-
<u>Bagrus</u>	10.2	5.6	11.6	1.8	-	-	-	-	-	-
<u>Momyrus</u>	0.7	0.4	1.2	0.4	2.0	0.3	0.5	0.3	0.2	0.1
<u>Barbus</u>	0.8	0.3	2.1	0.3	1.0	0.3	0.2	0.3	0.1	-
<u>Protopterus aetheopicus</u>	9.2	10.5	11.7	7.0	8.0	1.9	1.6	4.9	1.2	0.6
<u>Clarias mossambicus</u>	11.3	12.0	12.0	2.1	5.5	0.6	1.9	1.6	0.6	0.8
<u>Synodontis</u>	0.001	-	0.01	-	-	-	-	-	-	-
<u>Haplochromis</u>	0.2	1.1	2.4	-	-	-	-	-	-	-
<u>Labeo</u>	-	-	0.7	-	-	-	-	-	-	-

Source: (Compiled from monthly production statistics of Uganda Fisheries Department Office, Jinja)

Percentage of the Tilapia catch by species in 1965 and 1966 in the 4 - inch mesh gillnets from various landings of Lake Victoria in Uganda.

Total Catch (Nos)	<u>O.</u> <u>esculentus</u>	<u>O.</u> <u>variabilis</u>	<u>T.</u> <u>zillii</u>	<u>O.</u> <u>niloticus</u>	<u>O.</u> <u>leucostictus</u>
667351	87.14	9.81	2.26	0.69	0.09
30801	61.40	30.00	4.50	3.50	0.60
502752	83.38	8.78	1.05	6.79	-
178815	77.50	10.56	1.23	10.71	-
8830340	81.20	11.30	6.29	0.57	0.64
6083314	69.30	13.80	7.70	3.20	6.00
106748	57.09	4.59	4.06	34.26	-
108176	18.12	10.50	0.67	70.71	-

's catch. Extracted from Welcomme (1967).