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The impact of the introduction of Nile perch, *Lates niloticus* (L.) on the fisheries of Lake Victoria

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The piscivorous Nile perch was introduced into Lake Victoria some 30 years ago, since when it has completely transformed the fishing industry and the species composition of the fish fauna of the lake. The original multispecies fishery, based mostly on cichlids (haplochromines, tilapias), cyprinids (*Barbus, Labeo, Rastrineobola*) and siluroids (*Bagrus, Clarias, Synodontis, Schilbe*), has changed dramatically to one based on three species: the introduced Nile perch, the cyprinids, *Rastrineobola argentea* (Pellegrin), and the introduced Nile tilapia, *Oreochromis niloticus* (Linnaeus).

Within 25 years of its introduction the Nile perch became ubiquitous and now occurs in virtually every habitat with the exception of swamps and affluent rivers. It has preyed on all other species with profound effects, especially on the stocks of haplochromines. These originally comprised 80% of the total fish biomass in Lake Victoria, but have now decreased to less than 1% of fish catches from the Kenyan waters of the lake. The fishermen of Lake Victoria have adjusted to this ecological crisis by using large-meshed nets to catch Nile perch, which has become the most important commercial species. For the first time in the history of Lake Victoria, fish fillets are now being exported to several overseas countries: the fillets are all from Nile perch.

Key words: Lake Victoria; *Lates niloticus*; introductions; fisheries; *Haplochromis*; tilapia.

I. INTRODUCTION

Africa's three largest lakes, Victoria, Malawi and Tanganyika, have the three richest lacustrine fish faunas of the world. Lake Victoria, the largest of the African lakes, is the world's second largest freshwater lake. It has an area of 68 800 km^2, a maximum depth of 79 m, a mean depth of 40 m, and is shared by Kenya, Uganda and Tanzania. It lies between the two East African rift valleys, across the Equator at 0°21′N to 3°0′S and 31°40′ to 34°53′E. To Kenya, Uganda and Tanzania, it provides much-needed animal protein in the form of fish.

The origin and history of Lake Victoria is still the subject of some controversy and as yet no fully comprehensive and convincing account exists, although it is now thought that it was formed by tectonic activity (earth movements) during the Mid-Pleistocene about 750 000 B.P. (Greenwood, 1981).

There is good evidence for the existence of an earlier Lake Karunga in the region now occupied by the present Lake Victoria (Beadle, 1981). Lake Karunga dried out or was drained westward by faulting during the Mid-Pleistocene. Its fish fauna was exterminated but the fossil remains of fishes of Miocene age include two genera, *Lates* and *Polypterus*, found on the Rusinga mainland near the present day Winam (Nyanza) Gulf (Fryer & Iles, 1972). Although these genera occur elsewhere in Africa, they are not indigenous to Lake Victoria. Of particular interest is *Lates niloticus* (Linnaeus), which belongs to the family Centropomidae (order Perciformes) and is commonly referred to as the Nile perch. Although it may have existed in Lake Karunga, *L. niloticus* was absent from Lake Victoria until May 1960 when it was discovered in fish catches in the northern part of the lake near

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Jinja. A few years earlier (1955) *L. niloticus* had been introduced into Lake Kioga which is connected to Lake Victoria via the Victoria Nile, but the fish could not have entered Lake Victoria from this source because hydroelectric turbines at the Owen Falls Dam constitute an effective barrier.

It has been suggested that Nile perch may have entered the lake accidentally, from a fish pond in Uganda. This is most unlikely because around that time there was only one known fish pond in Uganda which had a few Nile perch (put there by the author in 1958), but this was at Kajansi Fish Farm, 90 km south west of Jinja. However, nobody has claimed responsibility and therefore the mode of entry of Nile perch into Lake Victoria, prior to its discovery in the lake in 1960, remains a mystery. The dramatic impact of this newcomer on the native fishes and fisheries of Lake Victoria, including the main socio-economic effects, are briefly considered here.

II. OFFICIAL INTRODUCTIONS OF NILE PERCH

INTRODUCTIONS IN 1962 AND 1963

The Nile perch was officially introduced into Lake Victoria when 35 fish from Lake Albert were stocked into the lake off Entebbe pier, in May 1962, by the Uganda Fisheries Department amid unsettled controversy for and against. In September 1963 the lake was again stocked with Nile perch when a further 339 fish from Lake Turkana were put into the lake, near Kisumu on the Kenyan side, by the Kenya Fisheries Department.

REASONS FOR THE INTRODUCTIONS

For some time prior to the official introductions of Nile perch there had been plans to introduce a predator to feed on the predominant '*Haplochromis*' species-flock, which constituted at least 80% of the demersal fish biomass, with an estimated minimum standing stock of 500 000 tonnes (Kudhongania & Cordone, 1974). At the time the haplochromines remained virtually unexploited by man, due to a very low demand on account of their small size and hard bones; the fishing community regarded them as food of the last resort. It was also argued that as *L. niloticus* co-exists with tilapias and other fishes in Lakes Chad, Turkana and Albert (Mobutu), it would do no harm to similar species in Lake Victoria. There was, however, considerable opposition amongst biologists, who argued that the success of such an experiment was far from certain and if, in the conditions of Lake Victoria, the tilapias became the main prey of Nile perch, then irreversible damage would be done to the important tilapia fishery.

In 1958 the author attended one of the meetings held in Entebbe, Uganda, at which the proposed introduction of Nile perch into Lake Victoria was discussed. The main reason advanced for introducing this particular fish was that the Nile perch is an excellent sport fish. In their report on the biology of the perciform fishes of Lake Turkana, Ogari & Hopson (1982) remarked that 'The Nile perch is also a valuable sporting fish and angling is one of the chief attractions for visitors to the safari lodges on the shores of the Lake'. Beadle (1981) states that 'Its size, strength and good flesh make it attractive both to commercial and sporting fishermen'. Rhodes (1966) in his report to the Kenyan Government, emphasizes that 'The

sport fisheries are of prime importance to the tourist industry which is of major significance in the development of the area '.

III. IMPACT OF THE INTRODUCTIONS

It is now 30 years since *L. niloticus* was introduced into Lake Victoria. Since then it has transformed the fishing industry and the species composition of the fish fauna more than any other phenomenon in this century. The multispecies fishery was originally comprised mostly of cichlids (tilapias, haplochromines), cyprinids (*Barbus, Labeo, Rastrineobola*), and siluroids (*Bagrus, Clarias, Synodontis, Schilbe*). Currently the fisheries are based on the introduced Nile perch, the native cyprinid, *Rastrineobola argentea* (Pellegrin), and the introduced Nile tilapia, *Oreochromis niloticus* (Linnaeus). In the Kenyan waters of the lake, the Nile perch is the most widespread species, contributing 68 000 tonnes or 60% of the total annual fish catch of 113 000 tonnes in 1987. The *Rastrineobola* fishery is second to that of the Nile perch, contributing 33 000 tonnes or 29%, while the tilapias contributed 10 000 tonnes or 9% of the total fish catch. All the other fish species are no longer significant in the catches and contributed only 2% of the total fish catch in 1987 (Table I). Unfortunately, little information is currently available on the three new fisheries mentioned above with regard to their interrelated population dynamics, and there is an urgent need for biological and stock assessment investigations.

Within 25 years of its introduction the Nile perch became ubiquitous in the lake and now occurs in virtually every habitat with the exception of swamps, and affluent rivers. It has preyed on all other species and has made a profound impact, especially on the haplochromines (Tables I and II). These originally comprised 80% of the total fish biomass in Lake Victoria but have now decreased to less than 1% in the fish catches in the Kenyan waters of the lake.

The Nile perch is a highly fecund species, each female producing 3–17 million eggs per spawning (Asila & Ogari, 1987). It matures at an age of about 2 years. Its longevity is not known but evidence suggests that it lives for up to 20 years (Ligtvoet, 1989). It grows to a very large size. The largest Nile perch recorded recently in Kenyan waters of Lake Victoria weighed 179 kg (J. Ogari, pers. commn.). Weights of 35–50 kg are common, but the best quality fillets are made from fish of about 10 kg (pers. obs.). The growth of the population in Lake Victoria has been very rapid. Having been introduced in Ugandan waters in 1962 and Kenyan waters in 1963, in relatively small numbers, it is remarkable that it has conquered the whole lake within 25 years. Initially at least, juveniles must have had a very high survival rate.

In contrast, members of the '*Haplochromis*' species-flock are very small (5–25 cm S.L. for adults and average weight of around 25 g). They produce very few eggs, with an average of only about 20 eggs per clutch (Witte & van Oijen, 1989). The rapid depletion of the haplochromine stocks indicates that they are very sensitive to cropping and, even in the absence of Nile perch, the haplochromines might have been depleted by the trawl fishery which was being planned for Lake Victoria. As haplochromines are no longer plentiful, the Nile perch now feeds on *Rastrineobola* and the crustacean *Caridina nilotica* (Roux), which increasingly are appearing in the gut contents of the predator.

TABLE I. Percentage contributions of different fish species to the total weight (tonnes) of fish landed from Kenyan waters of Lake Victoria over a period of 20 years*

Genus	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Lates		0·1	0·2	0·3	0·2	0·9	0·5	0·13	0·5	1·1	4·5	14·0	16·0	59·8	54·4	67·7	57·5	56·5	55	60	49
Haplochromis	22·8	36·8	32·7	32·0	29·0	33·2	35·0	27·9	34·0	32·4	27·8	21·6	13·5	2·4	4·2	0·8	0	0	0	0·1	1·1
Rastrineobola	4·5	2·9	3·2	5·1	7·8	10·5	21·8	27·4	30·3	34·7	36·5	30·5	35·1	20·0	17·1	21·3	27·1	29·2	34	29	33
Tilapiine	14·8	26·6	27·5	21·1	14·8	10·1	5·6	3·9	5·4	7·4	10·9	9·0	18·6	10·2	7·3	5·5	10·4	10·7	8	9	14
Clarias	10·6	7·6	9·7	12·5	17·0	15·7	12·9	15·6	13·0	9·1	7·2	10·0	4·5	2·6	3·4	2·7	1·1	0·6	0·7	0·3	0·2
Bagrus	7·0	5·5	6·7	7·1	5·4	8·6	6·4	8·4	5·5	6·0	5·9	5·8	2·4	1·1	4·2	3·1	0·1	0·1	0·2	0·1	0·1
Protopterus	17·2	9·3	11·0	12·8	12·7	13·0	8·6	1·1	5·0	4·0	2·6	1·5	1·4	0·5	0·4	0·3	0·1	0·2	0·2	0·1	0·0
Schilbe	2·4	1·4	0·4	0·4	0·4	0·9	0·2	0·3	0·3	0·7	0·5	1·0	0·4	0·1	0·1	0	0	0	0·0	0·0	0·0
Alestes	2·2	0·3	0·1	0·1	0·01	0·02	0·01	0·08	—	—	—	—	—	0	—	0	0	0	0·0	0·0	0·0
Barbus	3·1	1·1	1·3	1·6	1·7	1·1	0·7	1·7	1·0	1·0	0·8	1·4	1·6	0·8	1·1	0·1	0·1	0·1	0·1	0·1	1·6
Labeo	3·6	2·7	1·8	1·5	2·0	0·8	0·3	0·7	0·7	0·3	0·6	1·5	1·8	0·3	1·5	0·1	0·1	—	0·0	0·0	0·0
Mormyrus	0·3	0·4	0·5	0·5	0·5	1·1	0·8	0·3	0·5	0·5	0·6	1·2	1·2	0·5	4·4	0·3	0·1	0	0·1	0·1	0·0
Synodontis	1·1	1·5	1·1	0·7	1·3	1·3	1·1	0·8	1·0	1·6	0·6	1·6	1·4	1·3	0·4	0·1	0·1	—	0·0	0·0	0·0
Small mixed	10·4	3·6	5·0	5·2	7·9	3·8	1·9	3·8	—	—	—	—	—	—	—	—	3·3	2·6	1·0	0·1	1·0
Tonnes	16 357	17 442	16 400	14 918	15 989	16 797	17 175	16 581	18 680	19 332	23 856	30 592	26 914	45 667	60 958	77 327	71 854	89 589	103 000	113 000	125 071

*Source: Fisheries Department of Kenya, *Statistical Bulletin*.

TABLE II. Catch rate (kg h^{-1})* of demersal fish species in the Nyanza Gulf, Kenya

Genus	1969	1979	1981	1982	1986
Lates	1·12	46·3	169·0	169·0	273·0
Haplochromis	440·0	59·2	0	0·10	8·5
Mormyrus	0·34	0·01	—	—	0·5
Synodontis	2·31	0·16	0·20	0·01	0
Schilbe	0·54	0·01	—	0	0·03
Barbus	0·25	0·59	—	—	0·03
Bagrus	33·45	10·8	0·30	0·45	0·22
Clarias	23·23	2·5	0·10	0·48	0·14
Labeo	0·17	0·01	0·02	0·01	0
Oreochromis niloticus	0·58	3·45	15·60	13·3	7·6

*Sources: *Fisheries Abstracts* 1984, 1985, except for *Barbus*.

When Nile perch of large size started to appear plentifully in local catches of fish, the socio-economic impact on rural communities, especially in Kenya, was tremendous. It was the kind of impact akin to that experienced by American science when the first sputnik was launched. Not only were there exaggerated stories about the ability of the Nile perch to feed on other fishes, but it was also alleged that parts of human bodies had been found in its stomach. This, added to the fact that it was very difficult to cook by traditional methods, gave the Nile perch a bad reputation around the lake and its value per unit weight remained very low compared with other fish species. Many fishermen considered it was a menace to their fishing nets, which were destroyed by large specimens. To some scientists it was considered an ecological disaster, while to another group it was thought to be an experimental success. To the local scientists of the region it was considered a challenge.

The Nile perch has been condemned because after its establishment in the lake, populations of other fish species, some of which were considered a delicacy, declined rapidly and some even virtually disappeared from the fishery. Prior to the introduction of Nile perch, the lake fishery produced many species. Fishermen and fish consumers enjoyed this variety and had a wide choice. As the Nile perch spread, the variety of fish decreased until some people were left with nothing to eat except Nile perch.

While not denying that most fish species, especially the haplochromines, have virtually disappeared from the lake due to predation by Nile perch, it is necessary to point out that about 40% of the fish species in Lake Victoria are, at least partly, piscivorous. These include *Bagrus, Clarias, Schilbe, Synodontis, Protopterus* and some haplochromines. These, together with the human fishing pressure, when added to Nile perch predation, may have also contributed to the disappearance of many fish species. At the same time there has been a definite increase in commercial fish production, mainly due to the increase of Nile perch. The original unfavourable attitude towards this fish, for food, was founded on the traditional methods of cooking. However, with new improved methods of cooking, interest has of necessity shifted from the other species and Nile perch has found wider acceptance by local consumers. As a result the value per unit weight of Nile perch is rising.

Processing by smoking, frying it in its own oil, or filleting, has also gained it a wider market.

With the population explosion of the Nile perch and a sharp decline in the catch of more desirable fish species, the fishermen, and the fish traders most of whom are women, faced a serious crisis. As the problem became more acute following the dramatic upsurge in the Nile perch population, the future of the fishing industry seemed to be in jeopardy. Forced by these circumstances to find a use for the fish, the fishermen reacted quickly by adopting large mesh-size fishing nets to catch the Nile perch, while the women fish traders learnt how to fry and hot-smoke it for the local markets. At the same time, big industrial traders moved in with large insulated cold-storage trucks to transport Nile perch to filleting centres, from which fillets are exported to several overseas markets. Some fillets are also distributed to large hotels and supermarkets for the increasing domestic consumption. In the final analysis, Nile perch has become the most important commercial fish species, supporting a major and thriving industry on a scale not anticipated either by those who introduced it into Lake Victoria or by those who opposed its introduction into the lake.

Recent reports from the Kenyan and Tanzanian Fisheries Departments have remarked on the persistence of haplochromines in certain shallow-water habitats. In other areas where Nile perch densities have fallen, populations of haplochromines have reappeared. The British Museum (Natural History) recently (1986) sent a small collecting expedition to Lake Victoria and the author had the opportunity to meet some members of the expedition and hold discussions. The expedition collected more than 4000 specimens representing many different haplochromine species from several localities and a variety of habitats. Field observations from this material and from other collections obtained from different parts of the lake by a member of staff of Harvard University confirm that there has been a marked decline in the overall number of haplochromine cichlids and in some habitats certain species are no longer caught. A report by the British Museum (Natural History) on the specimens indicate that there seems to have been little change in species composition despite the very obvious presence of Nile perch. In yet other habitats the situation is seemingly as it was before the Nile perch invaded the area. The situation in Lake Victoria is by no means a simple one and the final consequences of Nile perch introduction in this lake is difficult to predict at the present time. From Table I it is obvious that the tilapiine species are also beginning to increase in the fishermen's catches. The introduction of alien fishes into Lake Victoria constitutes a large-scale experiment that is still in progress, and the extraordinary fluctuations in the fortunes of the lake's fishes may contain further surprises.

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