The paradox of international introductions of aquatic organisms in Africa

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Introduction and methods

Introductions and Transfers (briefly introductions) of aquatic organisms into and out of Africa are an old practice. Compared to other continents, the phenomenon is recent, approximately 150 years old. This time factor may, however, be a reflection of the absence of records. There are few major rivers and lakes in Africa which have not been subjected to deliberate or inadvertent introductions.

In the early 1980's FAO started a database on international introductions of inland aquatic fishes (WELCOMME, 1988). Recently, this database has been expanded, by distributing internationally a questionnaire and by performing a literature search, to include marine organisms and other aquatic taxa, such as molluscs and crustaceans (BARTLEY and SUBASINGHE, 1996), Coverage in the database is still uneven, probably being most complete for freshwater fish and most incomplete for aquatic plants. Although some introductions that have resulted from ballast water and fouling organisms are included, no effort has been made to include these inadvertent introductions.

The information in this report is derived from the FAO database. The data base indicates that over 2,800 introductions have been performed world-wide. Of these, 430 introductions were performed into Africa; about 30 out of Africa and about 140 among African countries.

The fundamental premise of this paper is that international introductions of aquatic organisms in and out of Africa is a paradox. These introductions reflect prevailing attitudes and values by the public and private sectors in which the primary concerns are socio-economic benefits. There is very little evidence that conservation, protection and the long term sustainable use of humans of components of biodiversity were central considerations.

Results and discussion

Species Introductions

One hundred and thirty-nine (139) species from 87 genera and from 46 families have been introduced into 42 countries. The majority of these organisms are finfishes (79%) with relatively small percent of molluscs (7%) and crustaceans (9%). The five most often introduced species were common carp (28 records), rainbow trout (19), large mouth bass (19), Nile tilapia (17) and grass carp (15). Thus, 1% of the species account for 23% of the introductions. By family, the most often introduced were Cichlidae (116), Cyprinidae (81), Centrarchidae (50) and Salmonidae (40). Similarly, 9% of the families account for 67% of the introductions. The large and varied number of species from tropical to temperate environments implies efforts to exploit almost all the aquacultural zones of the continent.

Three main waves of introductions are identified: before 1949 (93 records); 1950-1989 (226) and after 1990, 22 records. There are also 77 introductions of unknown dates. Figure 1 shows introductions per decade. The relatively high number of intro-

ductions between 1950-1959 (78) and 1960-69 (60) is a reflection of the search for the "appropriate" species for aquaculture development, for the stocking of man-made lakes and for the control of disease vectors and weeds. The subsequent reduction per decade after 1980 is apparently related to the growing awareness of the possible negative effects of species introductions and legislation, particularly in developed countries prohibiting such introductions.

Africa has received introductions from all continents except Oceania and Antarctica. The source of parent stock seemed to be linked to "colonial affinities". At the same time, Africa has also given to the other continents. The most remarkable of these exports was the Nile tilapia (*O. niloticus*) from four countries (Ghana, Egypt, Kenya and Senegal) to the Philippines). This parent material has been improved genetically under the Genetic improvement of farmed tilapia (Gift) Project by Iclarm researchers to become what is known as the "super tilapia" (EKNATH *et al.*, 1993). There have also been about 140 intra-African introductions of species. The intensities of introductions that is, number of introductions into and out of a country, for the ten countries that have had the most introductions is summarized in Table 1.

Country	No. introduced	Imported from Africa	Imported from Other	Exported to Africa	Exported to Other
South Africa	41	2	30	42	2
Morocco	37	1	34	2	1
Kenya	26	14	7	14	3
Zambia	26	18	6	5	0
Zimbabwe	25	18	2	5	0
Madagascar	24	9	13	3	0
Mauritius	23	7	14	1	0
Congo	20	15	4	10	1
Egypt	16	5	8	1	7
Tunisia	15	3	10	0	0

Table 1
Intensities of introductions for 10 principal countries.

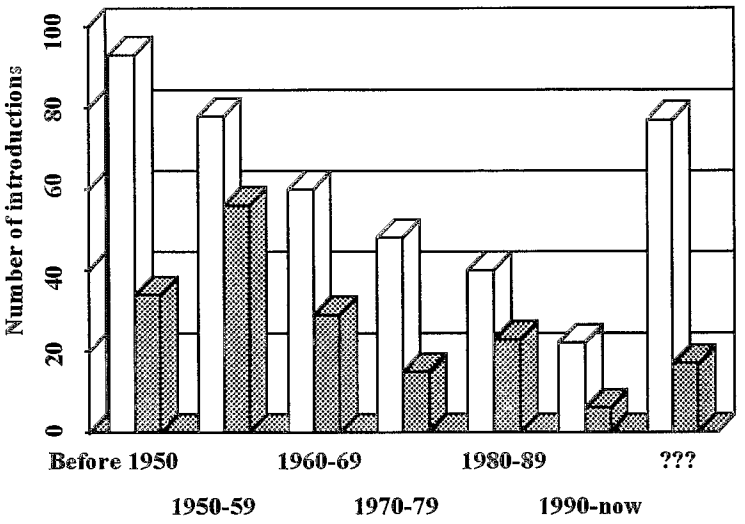

Figure 1
Numbers of fish species introductions per decades
(white, into African countries; black, out of African countries).

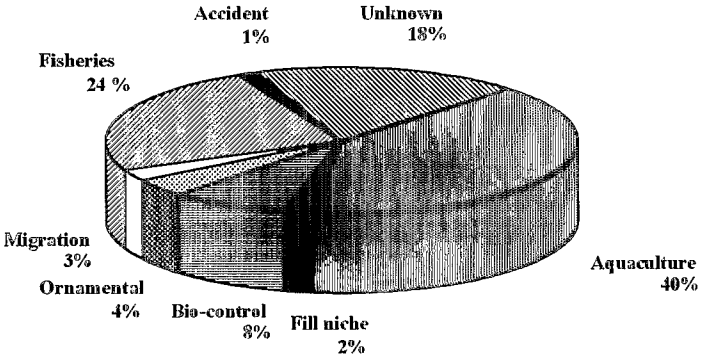

Figure 2
FAO data bank analysis of the reasons
for introductions of species.

Reasons for the Introductions

In many developed countries, species are often introduced to freshwater bodies to create sport fisheries. In most African countries, introductions have been promoted to produce high quality fish protein, alleviate poverty and hunger, as well as provide employment, control disease vectors and weeds. In the FAO data bank these different purposes have been grouped into three main classes: Aquaculture development, biological control and capture and sports fisheries.

Analysis of the data bank provides the results given in Figure 2. In addition to the above reasons there were five reported cases of accidents, 10 cases of migration to the wild and eight instances to fill vacant so called "niches". There were also 71 cases of unknown reasons of introductions.

Status and Impact of the Introductions

The status, impact and benefits of these introductions are summarized in Table 2. The objectives of some introductions could not be met but several species have become widespread in both rivers and lakes. In a number of particular instances, success has followed the introductions of species as a foundation for capture fisheries. This has been the case with the introduction of the voracious Nile perch (*Lates niloticus*) into Lake Victoria. This predatory species is reported to have contributed to the elimination of over 300 species of haplochromine cichlid and change the primarily small-scale artisanal fishery on the lake into a multi-dollar commercial fishery that supports industrialized processing and exportation ventures (PITCHER and BUNDY, 1996; MANN, 1970; OGUTU OHWAYO, 1990).

Another example is the pelagic Clupeid *Limnothrissa Miodon* into Lakes Kivu and Kariba and its accidental diffusion downstream to Lake Cahora Bassa, leading to the establishment of substantial stocks of fish that has formed the basis of important Kapenta/Sardine fisheries in these lakes and reservoir. The sardines have, however, altered the zoo plankton composition and possibly other aspects of the ecosystem (MARSHALL, 1991; MAYABE 1987; JACKSON, 1960). Yet a third important fishery that has been established through introductions is the *Heterotis niloticus* fishery

on the Nyong River in Cameroon (DEPIERE and VIVIEN, 1977). In the three cases cited, the current fishery provides two to three times as much fish before the introduction, and fish consumption in the areas of such fisheries have remained high despite significant increases in human population. However, these changes have also introduced a series of socio-economic problems from deforestation to provide fuelwood for processing to a shift in the rural economy of the locality (DEPIERE and VIVIEN, 1977; REYNOLD and GREBOVAL, 1989). However, overcapitalization of the various sub-sectors of the fishery could contribute to the collapse of the fisheries. With regard to aquaculture species, *Cyprinus Carpio* have become well established in many countries but the *Oreochromis sp.* remain the principal aquaculture candidate. It is reported (LAZARD, 1990) that the introduction of *O. niloticus* into Côte d'Ivoire has led to a significant development of fish culture in the country. It is, however, a paradox that, while Africa was/is scouting for the best fish species to be introduced for aquaculture, *O. niloticus* introduced into the Philippines from Africa was genetically improved under the GIFT Project.

Reason for introduction	Ecological effects	Socio-economic effects
Aquaculture - of the 153 reported introductions, 74 became established in the wild.	adverse 4	adverse 3
	beneficial 3	beneficial 6
	undecided 12	undecided 12
	blank 134	blank 132
Fisheries (sport and commercial)	adverse 7	adverse 0
	beneficial 5	beneficial 11
	undecided 2	undecided 2
	blank 80	blank 81
Biological control - of 32 reported introductions, 22 became established in the wild.	adverse 0	adverse 0
	beneficial 2	beneficial 3
	undecided 2	undecided 2
	blank 28	blank 27

Table 2
Status and impact of African introductions for the three most common reasons for introducing aquatic organisms.

Regrettably, very few broad spectrum analysis that take into account ecological as well as socio-economic parameters have been done on the introductions in Africa (BARTLEY, 1993; REINTHAL, 1993; COATES, 1995). Where analysis have been undertaken (Lake Victoria and River Nyong) it is reported that the fish fauna has been drastically altered; native species have been eliminated; the situation is virtually irreversible and the introduced fauna is established and cannot be removed easily in economic or practical terms. OGUTU-OHWAYO and HECKY (1990) report, however, that while the introduction of *L. Miodon* into Lake Kivu and Kariba reservoir has established highly successful fisheries, the effect on the pre-existing fish community or trophic ecology is very small.

It is important to note also that the effects of introductions could take a long time to manifest. In the three flourishing fisheries cited in this study the timeframe was 15 to 20 years. In general terms, the negative effects of introductions include the degradation of the host environment, the disruption of the host community through competition and displacement, stunting and predation as well as nuisance to the fisheries (LEVEQUE and QUENSIERE, 1988; OGUTU-OHWAGO and HECKY, 1990; MOREAU *et al.*, 1988). It is quite probable that impacts of species introductions are irreversible and unpredictable. Hence, recognizing the necessity, in the interest of present and future generations of humans, to protect the environment and its biota from any potential negative impacts, fisheries professional societies, governments, intergovernmental organizations, non-governmental organizations, etc. have contributed to the enactment/adoption of regulations, biosafety protocols and codes of practice on the responsible use of exotic species (FAO, 1995a,b; PULLIN, 1994). Foremost in this regard are the ICES/EIFAC Codes of Practices and Manual of Procedures for consideration of Introductions and Transfers of Marine and Freshwater Organisms (TURNER, 1988). The code has been adopted for use by the Committee for Inland fisheries in Africa (CIFA). These instruments emphasize a precautionary approach to species introductions in order to reduce the risk of adverse impacts on the introductions on capture fisheries and aquaculture; to establish corrective or mitigating procedures in advance of actual adverse effects; and to minimize unintended introductions to wild ecosystems and associated capture fisheries (FAO, 1997).

Conclusion

Africa faces a major challenge. There is, on the one hand, public outcry at the undesirable ecological consequences of some introductions. On the other hand, the contribution of some introductions to increase fish protein is undeniable. What mechanisms would permit the sacrifice of short-term gains to the present generation in order to realize long term gains for future generations. What strategies are appropriate in promoting conservation and sustainable use of biodiversity in the face of hunger and poverty.

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