The Introduction of Exotic Fish in Sri Lanka with Special Reference to Tilapia

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Abstract

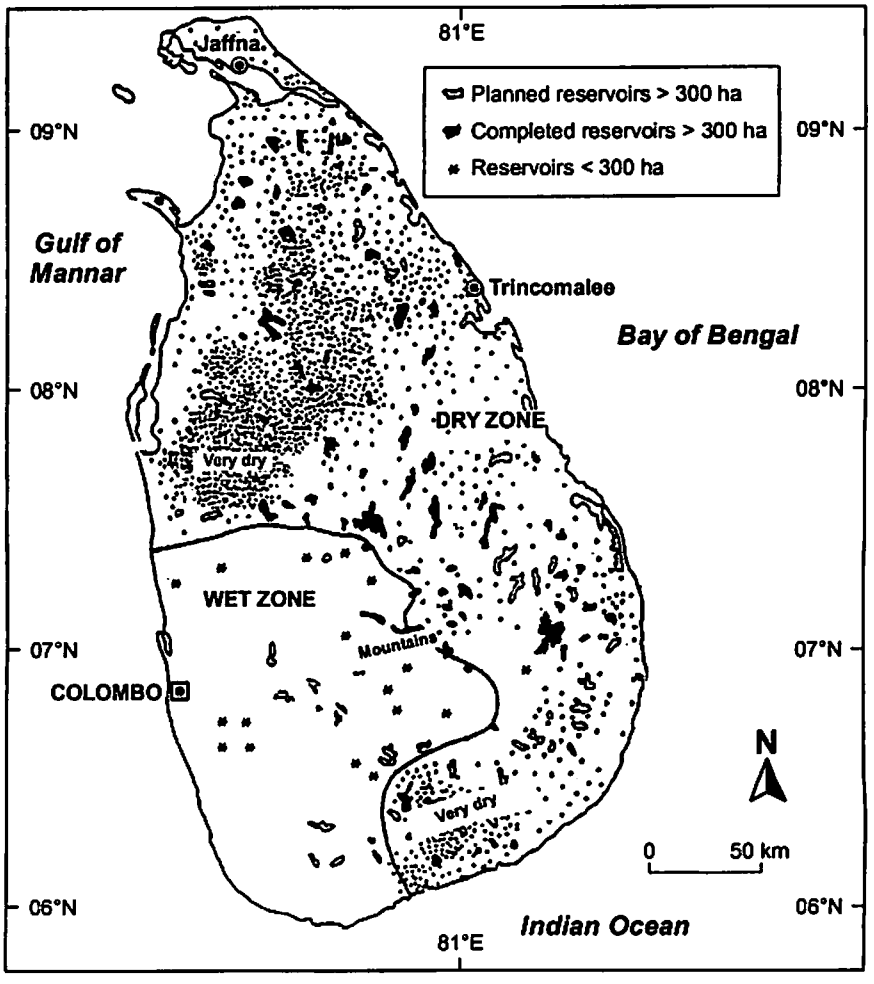
Introductions of exotic finfish between 1948 and 1953 are reported in this paper, with a brief reference to earlier and later introductions. Exotic fish were introduced principally to develop the potential for aquaculture in fresh and brackish waters in order to increase the availability of fish for rural communities through the biological control of aquatic vegetation. The algal feeding tilapia has created a new food industry in inland and brackishwaters. It has supplemented marine fishery production in a community where animal protein intake consists mainly of fish. It is also being cultured in flooded rice fields and used in the control of malaria. This excellent table fish has not had any adverse environmental impact.

Introduction

From the fifth century B.C. to the 12th century A.D., the Sinhalese colonists built reservoirs (known as *tanks* in Sri Lanka) to hold seasonal rainfall for the irrigation of rice and other crops. The larger *tanks* were kept full by a 60 km canal constructed from a weir at Minipe on the Mahaweli river, to divert part of its flow to irrigate a second rice crop during the dry season each year. Hundreds of small *tanks* dried up and many *tank* bunds were breached leaving mosquito infested marshes.

Tanks covered about 2% of the land, an estimated 130 000 ha at peak level use. Restoration work carried out in this century, as well as the building of new multipurpose dams (some of them over 10 000 ha each), and several feeder canals from river diversions have considerably increased their extent. As there were no natural lakes, these relatively new *tanks* have not had time to evolve a typically lacustrine fish fauna. Of the 51 species of indigenous river fish, those that entered the *tanks* were not ideally adapted to a still water habitat (Deraniyagala 1952). Not only were they preyed on by water birds and crocodiles, they were also eaten by the peasants.

In 1945, the author observed that the abundant aquatic flora that flourished during the annual rains decayed as irrigation draw-off and the intervening drought lowered the water level, adversely affecting the quality of the water on which the resident peasants were dependent for all their needs. Poor water quality and the notable insufficiency of



Map of Sri Lanka indicating tanks and other artificial reservoirs. (Source: Fernando 1998)

animal protein in their diets suggested that a suitable herbivorous lacustrine fish might convert the flora into edible fish and reduce its biomass (de Zylva 1954).

Materials and Methods

A study tour of the aquaculture industry in Malaya and Singapore was made during February-April 1948. This preceded the introduction of species selected from the resources available in Singapore (de Zylva 1952).

At that time in Singapore, the industry covered about 100 ha of ponds and was based on the rearing of several varieties of Chinese carp and other fishes in an association of complementary species. Chinese grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichths molitrix*) and big head carp (*Aristichthys nobilis)* predominated, with some black carp (*Mylopharyngodon piceus*) and mud carp (*Cirrhina molitorella*). Common carp (*Cyprinus carpio*) were also used.

About 2 million Chinese carp fingerlings were brought to Singapore annually from spawning grounds in rivers in south China. They were transported by sailing junks, in large vats, aerated by square wooden splashers activated by the crew. Farmers bought their supplies from four specialized fry markets in Singapore as artificially induced breeding by hypophysation was not yet in practice. Four or more of these species were farmed together.

When the supply of fry was disrupted after Japan's entry into World War II in 1942, farmers had to rely on locally available resources, which were the anabantids, sepat siam (*Trichogaster pectoralis*), gourami (*Osphronemus goramy*) and kissing gourami (*Helostoma temmincki*), common carp and the cichlid (*Sarotherodon mossambicus*).

S. mossambicus came into Malaysia in 1943 (Chimits 1955). A native of East Africa, it was brought into the Dutch East Indies (now Indonesia) by Dutch settlers in 1939 (Huet 1986).

Three species of Chinese carp were selected for polyculture, namely, grass carp, silver carp and bighead carp, together with the common carp for weed utilization and polyculture, the anabantids *Trichogaster* and *Helostoma* for rice field weed control and food, and *S. mossambicus* for conversion of algae into edible fish.

The fingerlings of *S. mossambicus* required packaging that would survive a 16-hour journey, 8 hours for the flight to Sri Lanka and a few hours for handling at either end. The Singapore merchants were using the 4-gallon metal cans in which motor fuel and kerosene were stored and transported at that time.

Two slender pipes welded into the cap extended half way into the can, and short lengths of rubber tubing were attached to their outer ends. The fry were starved for 24 hours to ensure complete evacuation of faeces before packing. They were counted into a half-filled can, water was topped up to the brim and the cap screwed on firmly. Oxygen at atmospheric pressure was bubbled in through one tube and the water coming out of the other ran into an empty can until it was half full. The pieces of rubber tubing at the outer ends of the pipes were bent over and tied to secure the contents. Several experimental packs of single species were made in order to determine the number and size of each species that would survive (de Zylva 1952).

Additional nursery tanks were prepared at the Research Station in Colombo to supplement the existing ponds at Narahenpita on the outskirts of the city. Nursery tanks already existed in Minipe, near the weir on the Mahaweli river and at Polonnaruwa, in the North Central province, for breeding stocks of the indigenous pearl spot (*Etroplus suratensis*) and the giant gourami (*O. goramy*) introduced in 1909 (de Zylva 1959). Ponds were prepared at agricultural farm schools. A specialized van for fingerling transport was provided. Chinese grass, silver and big head carp arrived from Singapore in the latter half of 1948. Further imports of grass carp were made in 1949, 1950 (de Zylva 1952), 1952 (de Zylva 1953) and 1954 (Goonewardena 1955). As they would not breed in nature, the government built a hatchery and on-growing ponds for induced breeding in the early 1970s at Udawalawe, one of the new multipurpose dams.

H. temmincki, T. pectoralis and *S. mossambicus* were introduced in 1950 (de Zylva 1952). *S. mossambicus* was breeding in nature by 1951 making further imports unnecessary. The Singapore strain of *C. carpio* and *T. pectoralis* had established breeding populations by 1952 (de Zylva 1953). Both species were distributed in ponds, *tanks*, rivers and canals.

Results

A grass carp weighing 8.6 kg with a 76.9 cm fork length was taken from a Colombo pond twenty-three and a half months after introduction as a 7.6 cm fingerling. Its body cavity contained a large quantity of fat. Common carp from the same pond weighed 2.25 kg with a 44.5 cm fork length (de Zylva 1952). A gourami from a Colombo lake weighed 3.6 kg at 49 cm two years later (de Zylva 1952).

S. mossambicus (called 'tilapia' throughout Sri Lanka) bred profusely, fingerlings attaining a length of 20 cm and a weight of 112 gm in six months in departmental ponds (de Zylva 1953). Fishers caught tilapia up to 37.5 cm long in the larger tanks (de Zylva 1954). A fishery developed in the brackish Mundel lagoon in 1953, two years after it was stocked, comprising 80% tilapia. This lagoon became a stock resource. Two agricultural research stations using *S. mossambicus* and *T. pectoralis* in rice-cum-fish trials found that the fish improved crop yields (de Zylva 1955). The farmers caught

Fry pond.

Live grass carp for sale in market. Note grass loop for lifting fish.

Hauling up the net.

the fish for food when the fields dried out a week before harvest. They had grown from 3.5 cm to 13-15 cm in six months and were already breeding. They controlled pest larvae and algae and added nutrients to the fields (Fernando 1989). Fish culture in paddy fields was already widespread in Southeast Asia and India. The 370 000 ha of rice fields under cultivation in Sri Lanka at that time represented a potential fish resource.

In the largest of the ancient *tanks*, the Parakrama Samudra in Polonnaruwa, tilapia had yielded 1 kg/ha/yr before stocking. By 1958, it represented 80% of the catch by weight and a viable commercial fishery had been established. Even after the introduction of *O. niloticus* in 1983, *S. mossambicus* dominated the catch. Tilapias have comprised between 52 and 94% of the mean yield of 227 kg/ha/yr since 1958 (Fernando 1989).

Traditional marine fishers from the west coast migrated with their log rafts and driftnets to the safety of the perennial *tanks* where they could fish all year round. The author visited the fishers and learned that they set their nets at dusk and hauled them in before dawn when traders purchased the larger fish. These were sold in the local market and any surplus was sold fresh in the main centers and inland towns, where it overcame consumer preference for sea fish which it resembled. In some inland fisheries dugout canoes were used. Fiberglass canoes introduced later made no appreciable improvement in the catch.

Predation by cormorants and several endemic species of *Ophiocephalus* sp. reduced stunting of the rapidly breeding tilapia. This was assisted by drift netting, as fishers sun-dried all the small fish that the traders did not take. Dried fish sold promptly as country folk had little if any access to refrigerators.

In 1982, 28 000 t of tilapia were harvested, 95% of which were *S. mossambicus*. This represented 86% of the total freshwater catch and 17% of Sri Lanka's total fish supply (Pullin 1985).

Reliable statistics from 18 *tanks* surveyed in 1985 showed that *S. mossambicus* dominated the fishery with yield ranging from 71 to 579 kg/ha/yr. In 10 of the *tanks* it accounted for over 70% of the landings. Catch statistics covering 5 years in two perennial *tanks*, Parakrama Samudra and Minneriya, showed that catch per unit effort declined significantly as fishing pressure grew. In the 2382 ha Udawalawe *tank*, created by one of the new multipurpose dams, specimens ranged from 17 to 38 cm in length, and weighed between 105 and 680 g, with an average of 213 g (de Silva 1985).

Production increased from 16 700 t in 1978 to 36 000 t in 1983 as a result of improved culture practices and effective extension services. It declined from 31 000 t in 1990 to 12 000 t in 1994 after the government stopped subsidizing inland fisheries and the fingerling stocking program. Restocking with fingerlings was an essential service as the majority of *tanks* dried out partially or totally every year. The intended transfer of technology to the private sector or to cooperative or village associations did not materialize because of a lack of commitment in the Ministry of Fisheries. This transfer would have averted the negative impact experienced as a result of stopping government assistance (MFARD 1995).

A 1992 report stated that over 40 000 t of tilapia from inland waters and lagoons were sold in the markets. The relatively shallow waters of the *tanks* and lagoons, with their gentle gradients, provided a favorable and abundant food supply, accounting for the unprecedented yield of this species.

Early Introductions

The Ceylon Fishing Club introduced the brown trout (*Salmo trutta fario*) in 1882 from Europe to stock high elevation streams for sport fishing and established a hatchery for its propagation. Some natural spawning was reported. The rainbow trout was introduced from the UK in 1889 for the same waters and was said to be breeding freely above the 1 220 m contour. Frequent consignments of eyed ova were imported until the early 1950s from the Surrey Trout Farm in the UK for ongrowing in the high elevation hatchery to sustain this controlled fishery.

In 1915, the Club also imported the partially scaled mirror carp and

the scaleless leather carp (varieties of the common carp) for stocking in an 1 800 m elevation reservoir for angling. These species established a breeding population and are still fished there. In 1935, a few mirror carp were successfully moved into a 1 000 m elevation hydroelectric dam and in 1938 into a pond in Colombo at sea level.

The herbivorous giant gourami, a valuable food fish, introduced by the Club from Java in 1909, was widely distributed in a number of dams and reservoirs including the 1 240 m Drayton Dam on the Mahaweli river. Escapees from the dam, reported in a marshy region at Mannampitiya, 160 km down-river, provided a small commercial fishery by 1916 (de Zylva 1954). Specimens stocked at the fish culture station in Colombo in 1938 were bred for distribution, but the program was suspended during the war years and resumed in 1950. In 1952 the recently constructed Gal Oya reservoir was stocked with 500 gourami and by 1954 a large number of the stocked ponds and lakes had breeding populations.

Gathering the fry.

Discussion

Occasional controversy arose through misunderstanding. For example, in 1953, fishers in the large prawn fishery in Mullaittivu lagoon on the northeast coast complained that their fishery had been decimated by tilapia. Five clans operated a mass fishery for tilapia and customarily took turns to fish on successive days. They cut open a mound of fish that they had farmed, but not one intestine contained any trace of prawn exoskeleton. Only filamentous green algae were found. It was then noted that the prawns had not breached the sandbar at the mouth of the lagoon, as they normally did each year. The seasonal rains had failed and the level of the water in the lagoon had not risen as much as usual. When it was understood that this accounted for the lack of prawns in that year's fishery, as the adults had not been able to migrate into the sea to breed and replenish the stock, the sand bar was quickly cut. The fishery resumed normal productivity in the following year.

S. mossambicus feeds on floating algae that give safe refuge to mosquito larvae and is excellent for indirect control of malaria. This is an important factor in a country where malaria is endemic and takes a considerable toll (Pullin 1985).

Although tilapia is a warm water fish with optimum development at temperatures between 20°C and 30°C, they can survive at 12°C. Their hardiness, resistance to disease, low respiratory demands, ease of transport, ready reproduction and the adaptability of some species to the euryhaline conditions and brackishwater are responsible for their wide range of distribution and successful dispersion from their original habitat. The choice of a number of herbivorous species is an added advantage (Huet 1986).

A collaborative research project, Genetic Improvement of Farmed Tilapias (GIFT) co-funded by the Asian Development Bank (ADB) and the United Nations Development Programme (UNDP) has been implemented by ICLARM since 1988. Designed to develop genetically improved tilapia strains to improve the poor status of Asian farmed stocks, the project is using resources of germplasm from Africa, evaluating promising strains of *O. niloticus* and establishing base populations to enhance production (Pullin et al. 1997). A genetically enhanced breed has been developed through selective breeding and has been successfully tested in Bangladesh, China, Indonesia, Thailand and Vietnam.

Conclusion

The objective of developing aquaculture and inland fisheries is to reduce poverty by increasing gainful employment, income opportunities and nutrition, particularly in the rural areas.

By 1994, the fisheries sector provided 2.8% of the GDP. The inland fisheries and aquaculture potential of over 175 000 ha of perennial and seasonal reservoirs has not yet been fully exploited. Over 120 000 ha of brackishwater lagoons, estuaries, mangrove swamps and salt marshes and 15 000 ha of coastal land and a number of bays bordering the coast are suitable for brackishwater aquaculture and marine farming.

One hundred fifty thousand people are directly engaged in fisheries including aquaculture, and another 30 000 in associated fish trade, processing, construction of fishing vessels and gear and in public sector agencies. Over 700 000 depend on fisheries for their livelihood.

Per capita domestic fish consumption fell steadily from 14 kg in the early 1980s to 11 kg in 1990, although inland fish production rose from 16 700 t in 1978 to 36 000 t in 1983. Production continued to decline from 31 000 t in 1990 to 12 000 t in 1994, as a result of the cessation of government subsidies to inland fisheries and the reduction of fingerling stocking programs. The fall in per capita consumption was caused largely by the shortfall in domestic fish supply, the highly elastic demand and population growth.

Between 1991 and 1994, per capita consumption rose to 15 kg based on imports and increased offshore fishery production. The projected expansion of inland fish production in the 5-year national development plan is expected to increase per capita intake and protein availability in the rural areas.

The environmental impacts of tilapia were investigated during the GIFT project introductions of *O. niloticus* in five countries and no evidence was found of species displacement or any of the other risks that have been attributed to their presence (Pullin et al. 1997).

The introduction of tilapia has had no adverse environmental impact on biodiversity in Sri Lanka. It has made a considerable contribution to the supply of animal protein food which has been deficient in rural diets and has created a new industry. It has further enhanced the quality of life by improving rice yields, malaria control and recycling of aquatic vegetation thereby making potable water available in village settlements.

Acknowledgment

The assistance afforded through FAO ETAP for training of staff in aquaculture by Dr. S.W. Ling over several months in 1955 is acknowledged.

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