EXOTIC FISHES AND FRESHWATER FISH DIVERSITY

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Abstract

The freshwater aquatic biodiversity is depleting alarmingly due to the introduction of exotic species and other anthropogenic activities. The indiscriminate transfer of exotic fishes has brought about a wide array of problems including extirpation of indigenous species. The exotics compete with the indigenous species for food, habitat and may even prey upon them, introduce new parasites and diseases, result in the production of hybirds and cause genetic 'erosion' of indigenous species and degradation of the physico-chemical nature of aquatic ecosystems. The potential risks not only affect the biodiversity, but also the socio-economic aspects of the human community that depend on aquatic ecosystems for their sustenance. The paper reviews the impact of exotic fishes on aquatic biodiversity in India and the measures to check this.

Keywords

Biodiversity, exotic fish, indigenous fish, conservation, ecosystem

Introduction

The aquatic biodiversity of the world is changing and getting depleted alarmingly fast as a result of extinctions caused by habitat loss, pollution, introduction of exotic species, over exploitation and other anthropogenic activities (Moyle & Moyle, 1995). The loss of aquatic biodiversity is severe in freshwater ecosystems, which represent a meagre 0.1 per cent of earth's water wealth, yet they habour 40 per cent of the fish species so far recorded (Nelson, 1994). Fishes are the keystone species which determine the distribution and abundance of other organisms in the ecosystem they represent and are good indicators of the water quality and the health of the ecosystem. Nearly 20 per cent of the world's freshwater fish fauna is already extinct or is on the verge of extinction (Moyle & Leidy, 1992).

In the long run introduction of exotic species may turn out to be a deleterious problem as habitat loss. According to Nyman (1991) this could also lead to irreversible changes in the aquatic ecosystems and result in extinction of species. An introduced species (exotic) is any species intentionally or accidentally transported and released by man outside its present range (Kottelat & Whitten, 1996). Exotic species of fishes were introduced in many parts of the world for:
(i) improving local fishery potential and for broadening species diversity in aquaculture programmes,
(ii) sport fishing,
(iii) for aquarium keeping, and
(iv) controlling of unwanted organisms (mosquitoes).
Further, there are accidental and/or unauthorised introductions. Also, exotic organisms introduced in one country may find their way to the neighbouring countries.

The indiscriminate transfer of aquatic organisms, particularly fishes, brought about a worldwide concern as it resulted in a wide array of problems including extirpation of indigenous species. The exotics are a competition to indigenous fishes for food and habitat. They may prey upon native fishes, introduce new diseases and parasites, result in the production of hybirds and cause genetic 'erosion' of indigenous species and degradation of the physico-chemical nature of aquatic ecosystems. All this will subsequently lead to loss of biodiversity (Nyman, 1991). There are several reports on the ecosystems level and species level catastrophic impacts of exotic introductions. The potential risks not only affect the quality or level of biodiversity, but also the socio-economic aspects of the human community that depend on aquatic ecosystems for their sustenance (Philipp *et al*., 1995).

Welcome (1988) reported that 168 species of fishes, representing 37 families have been introduced outside their natural distribution range world over, and a minimum of 67 species have become established in different water bodies, with 27 species turning out to be real pests. Experts also opine that transfer of fishes to different habitats within the country should also be done with as much precaution as those across the borders (Kottelat & Whitten, 1996).

A typical example of the disastrous effects of introducing species

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is available from lake Victoria, the world's largest tropical lake (Stiassny, 1996). In the 1970s there were over 300 endemic cichlid species, representing 99 per cent of the lake's fish species. Eight million humans in Kenya, Uganda and Tanzania depend on this lake for food. The physical and biological properties of the lake changed considerably since the introduction of the exotic fish, Nile Perch (*Lates niloticus*). The majority of cichlids endemic to the lake became extinct and now the group represents only one per cent of the lake's fish diversity!

Exotic fishes in India

During the last several decades, over 300 species of exotic fishes have been brought into India for experimental aquaculture, sport fishing, mosquito control and aquarium keeping besides a species of mollusc (*Mytilopsis sallei* native of Central America, introduced into Indian waters probably through ship fouling) and several obnoxious aquatic weeds (*Eichornia crassipes*, *Salvinia molesta*, *Pistia stratioides* and *Ipomea carnia* from tropical South America. Besides this there are reports of clandestine introduction of dangerous fishes. A list of the important species introduced to Indian waters, the country form which they are introduced and the date and purpose for introduction is given in Table 1.

Several exotic species of fishes are now established in the natural water bodies of India. Although not many studies have been carried out on the impacts of exotic species in Indian waters, reports form elsewhere unequivocally prove the devasting impacts of exotic fishes such as Tilapia, Silver Carp, Gambusia and Common Carp in aquatic ecosystems.

Table 1. Exotic fishes transplanted in India

Species	Home country	Year of introduction	Purpose
A. Game fishes			
1.Brown Trout (*Salmo trutta fario*)	U.K.	1863- 1900	For planting streams, lakes and reservoirs
2. Loch Leven Trout (*Salmo levensis*)	U.K.	1863	For planting streams, lakes and reservoirs
3. Rainbow Trout (*Salmo gairdneri*)	Sri Lanka & Germany	1907	For planting streams, lakes and reservoirs
4. Eastern Brook Trout (*Salvelinus fontinalis*)	U.K.	1911	For planting streams, lakes and reservoirs
5. Sockeye Salmon (*Oncorhynchus nerka*)	Japan	1968	For planting streams, lakes and reservoirs
6. Atlantic Salmon (*Salmo salar*)	U.S.A.	1968	For planting streams, lakes and reservoirs
B. Food fishes			
1. Golden Carp (*Carassius carassius*)	U.K.	1870	Experimental culture
2. Tench (*Tinca tinca*)	U.K.	1870	Experimental culture
3. Gourami (*Osphronemus goramy*)	Java & Mauritius	1916	Experimental culture
4. Common Carp (*Cyprinus carpio*) [German Strain]	Sri Lanka	1939	Experimental culture
5. Tilapia (*Oreochromis mossambicus*)	Africa	1952	Experimental culture
6. Common Carp (*Cyprinus carpio*) [Bangkok strain]	Thailand	1957	Experimental culture
7. Grass Carp (*Ctenopahryngodon idella*)	Japan	1957	Experimental culture and weed control
8. Silver Carp (*Hypophthalmichthys molitrix*)	Hong Kong	1959	Experimental culture
9. Tawes (*Puntius javanicus*)	Indonesia	1972	Experimental culture
C. Larvicidal fishes			
1. Guppy (*Poecilia reticulata*)	South America	1908	Mosquito control
2. Top Minnow (*Gambusia affinis*)	Italy	1928	Mosquito control
D. Ornamental fishes			
1. Live bearers (27 species)	From various countries		Aquarium keeping
2. Egg layers (261 speceis)	From various countries		Aquarium keeping
E. Unauthorised introductions			
1. Bighead Carp (*Aristichthys nobilis*)			Aquaculture
2. African Catfish (*Clarias gariepinus*)			Aquaculture
3. Nile Tilapia (*Oreochromis niloticus*)			Aquaculture
4. Red Tilapia (*Oreochromis* sp.)			Aquaculture
5. Red Piranha (*Serrasalmus nattereri*)			Aquaculture keeping

Though the introduction of the African cichlid, *Oreochromis mossambicus* (Tilapia) in India has been claimed as a success story by fishery experts, the species seem to have caused unanticipated impact on both freshwater ad brackishwater fisheries. Though it is a species adapted for riverine life (Trewavas, 1983), it was introduced extensively in lentic water bodies (ponds, lakes and reservoirs) in India. Being a prolific breeder and a hardy fish, Tilapia now dominates indigenous ichthyofauna in many water bodies of India. Studies on fish diversity of Bharathapuzha, the longest river in Kerala, showed abundant population of Tilapia, replacing native fish fauna in many areas (Bijukumar & Sushama, in press).

In Asia, the endemic goby *Mistichthys luzonensis* in Lake Buhi is facing extinction due to the introduction of *Oreochromis mossambicus. O. mossambicus*, because of similar ecological requirements may compete with indigenous cyprinid fishes such as Labeo and may challenge their very survival (Kottelat & Whitten, 1996). In Asian countries there are reports of disapperance of freshwater turtles due to frequent gill net fishing to collect Tilapias (Pethiyagoda, 1994.).

In India the introduction of *Cyprinus carpio* var. *specularis* into Dal lake and Loktak lake has been reported to affect the population of indigenous *Schizothorax* sp. and *Osteobrama belangeri*, resectively. The population of native Catla and Mahseer were depleted considerably in Govind Sagar reservoir after the introduction of Silver Carp (Menon, 1979; Molur & Walker, 1998). Introduction of Silver Carps in Indian reservoirs has had in general, a negative impact on fish diversity.

The Mosquito Fish (Gambusia) and Guppy introduced to India may also have had negative impacts on aquatic biodiversity. The Mosquito Fish are prolific breeders and are capable of entering into the microhabitats of rare, native species and are, in many instances, reported as predators (Rinne, 1995). Numerous local cyprinodont population and species in Europe and North America are threatened by introductions of non-native Mosquito Fish, *Gambusia affinis* (Turner, 1983; Elvira, 1990). Considering the negative impacts of Mosquito Fish, the famous ichthyologist Myers (1965) labelled this species as the "fish destroyer". Similarly, reports of IUCN (1986) indicate that the introduction of Guppy (*Poecilia reticulata*) has caused a number of extinctions world over.

The introduction of sport fishes has been considered so far as non-problematic in Indian waters (Shetty *et al*., 1989). However, trouts are reported to compete with native stocks, leading to their elimination and may even hybridize with genetically similar indigenous species (Rinne, 1995). Introduced sport fishes such as Rainbow Trout are found to be a major predator on the eggs and young ones of native species (Blinn *et al.*, 1993). These reports beg further investigations on the impact of introduced sport fishes in Indian waters.

Carnivorous and voracious feeders such as the Bighead Carp (*Aristichthys nobilis*) and the African Catfish (*Clarias gariepinus*) and the infamous aquarium fish, the Red Piranha (*Serrasalmus nattereri*) were imported to India illegally. If these exotic fishes establish themselves in natural water bodies, they may become a very serious threat to the smaller indigenous fish species as well as invertebrates. Swarms of piranhas confined to small water bodies may attack large animals and even human beings. With their sharp teeth it is no problem for this fish to strip their victim to the bone within a short while. Piranhas are also the bane of fisherman because they devour other fishes caught in the nets (Frey, 1961).

Considering the threats posed by the African Catfish and piranhas, the union agriculture ministry has ordered killing of these fishes *en masse*. The government order did not have any impact as it lacked any specific guidelines to be adopted for destroying the fish. Both these fishes are bred in different parts of the country and in Kerala the author visited several aquarium shops supplying the carnivorous Red Piranha and farms supplying seeds of African Catfish.

Dangerous exotic fishes kept in ponds may escape into the natural water bodies through any small water outlet. There is the possibility of accidental release through the agency of fish-eating birds and mammals. Some people may (knowingly or unknowingly) introduce these fishes directly into natural water bodies; recovery of exotic aquarium fishes from the natural waters of Kerala (Ajith Kumar *et al.*, 1998) stand testimony to this. All this implies the need for the total elimination of these exotic species for which there must be stringent laws and public awareness.

In India there had been a trial by Hindustan Lever to culture the American Channel Catfish, *Ictalurus punctatus* (Molur & Walker, 1998). They had imported seeds directly from United States and started culturing them. The trial somehow failed to produce desired results. A proposal has also been made for the cage culture of exotic species such as *Dicentrachus labrax* and *Sparus aurata* in the Lakshadweep and Andaman and Nicobar Islands (Molur & Walker, 1998). As both these fishes are carnivorous and capable of breeding in open waters, such moves should not be encouraged as they impose unforeseen effects on the aquatic biodiversity of our country. Transfer of parasites and diseases along with the introduction of exotic fishes has also been reported from India (Shetty *et al.*, 1989).

Introduction of fish to different habitats within the country may also lead to loss of biodiversity. Grass Carp introduced in Donghu Lake, Wuhan (China) caused the complete elimination of aquatic macrophytes, which subsequently resulted in plankton blooms.

The Bighead Carp and Silver Carp, which were not native to this lake were introduced to feed on the plankton. They dominated the lake, resulting in the virtual disappearence of all the 60 fish species native to the lake. The benthic invertebrate species were reduced from 113 to 26 and zooplankton, from 203 to 171. The appearance of algal blooms every summer now affects the supply of drinking water to the residents (Chen, 1989, cited by Kottelat & Whitten, 1998). Such studies, however, are not initiated in India.

Conservation of aquatic biodiversity

Considering the negative impact of exotic fishes on aquatic biodiversity, stringent regulations should be framed regarding the import of non-native fishes. As per rule, the exotic fish varieties should be cleared by the National Committee on Introduction of Aquatic Species in Indian Waters, New Delhi before introduction. The committee represented by fisheries development commissioner and experts will study the relevance of import and the potential impact that the new species is likely to produce on Indian aquatic environment. However, illicit import and trade of exotic fishes, particularly that of the carnivorous aquarium fish piranha, continues unabatedly and there are no effective methods nor the political will to enforce the law. The situation warrants a revision of the existing laws and procedure for their implementation. A code of practice, preferably following the guidelines of de Silva (1989), European Inland Fisheries Advisory Commission (EIFAC) and International Council for the Exploration of the Sea (ICES) to be adopted to minimise the risk of introduction of species. Proper quarantine standards also be insisted while importing aquatic organisms.

With the rapid increase in the human population and the increasing dependence on aquatic resources including water and the continuing introduction of exotic species in natural water bodies, the loss of aquatic biodiversity is likely to increase further unless proper conservation measures are implemented. Detailed investigations should be initiated to locate the impact of all the introduced species in various water bodies, followed by steps to eradicate the deleterious species.

Conclusions

India is one of the mega diversity countries with respect to freshwater fish species (650+ species) (Molur & Walker, 1998). In freshwater fish diversity India is eighth in the world and third in Asia (Kottelat & Whitten, 1996). There are plenty of culturable species and any further introduction of exotic fish species is unnecessary. For example, with such a variety of culturable catfishes such as *Pangasius pangasius*, *Aorichthys seenghala*, *A. aor*, *Wallago attu*, *Clarias batrachus* and *Heteropneustes fossilis* (Molur & Walker, 1998) why should we go for exotic catfishes? The need of the hour is to protect the existing indigenous fish stock and steps for enhancing the quality of the culturable species rather than go in for indiscriminate introduction of exotic species.

The indigenous fishes should also be incorporated into the value systems of the society (sport, biological control, aesthetic, etc). Indian fishes such as *Macropodus* and *Aplochielus* are effective in mosquito control. Similarly, there are several splenderously coloured native ornamental fishes (Harishanker & Bijukumar, 1998). India has to develop baseline data on the natural population potential of the indigenous species. Extreme risk areas should be indentified for effective monitoring and conservation programmes. The water bodies harbouring endangered fishes must be declared as fish sanctuaries or aquatic diversity management areas.

Presently, our freshwater biodiversity is in peril. Checking the entry of exotic species coupled with more awareness on the indigenous species would go a long way in preserving our rich aquatic biodiversity.

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