

ALIENS; A CATASTROPHE FOR NATIVE FRESH WATER FISH DIVERSITY IN PAKISTAN

A. M. Khan, Z. Ali, S. Y. Shelly* Z. Ahmad** and M. R. Mirza**

Department of Zoology, University of the Punjab, Lahore

*Department of Fisheries, Government of Punjab, Munawan, Lahore.

**Department of Zoology, Government College University, Lahore

Corresponding author e-mail: memorablefish123@gmail.com

ABSTRACT

Pakistan has introduced several alien exotic fish species e.g. grass carp (*Ctenopharyngodon idella*), bighead carp, (*Hypophthalmichthys nobilis*), silver carp, (*Hypophthalmichthys molitrix*), common carp (*Cyprinus carpio*), gold fish (*Carassius auratus*), and three species of tilapia (*Oreochromis aureus*, *Oreochromis mossambicus*, *Oreochromis niloticus*) in warm waters along with two trout species: the rainbow trout (*Onchorynchus mykiss*) and the brown trout (*Salmo trutta fario*) in colder regions for specific purposes like sport fishing, yield enhancement and biological control of aquatic weeds and mosquitoes. The exotic species are becoming invasive in the freshwater biomes of the Punjab and other provinces of Pakistan by reason of their potent reproductive potential and feeding competitions with the native freshwater fish fauna. Resultantly the native fish species viz; *Channa marulius*, *Wallago attu*, *Rita rita*, *Sperata sarwari*, *Gibelion catla*, *Cirrhinus mrigala* and *Labeo rohita*, which are of economic value are under threat.

Key words: Exotic, invasions, freshwater, fish fauna, Pakistan.

INTRODUCTION

There are more than 186 freshwater fish species described from freshwater bodies of Pakistan. Substantial quantities of commercially important fish are caught from rivers annually. The inland commercially significant native fish fauna comprises about 30 species of which the economically important species are: *Labeo rohita*, *Gibelion catla*, *Cirrhinus mrigala*, *Cirrhinus reba*, *Channa straita*, *Channa marulius*, *Sperata sarwari*, *Wallago attu*, *Rita rita*, *Bagarius bagarius*, *Tenualosa ilisha*, *Notopterus notopterus*, *Nemacheilus* spp., *Tor macrolepis*, *Schizothorax* spp and *Clupisoma naziri* (Peter, 1999).

Although exotic introductions are often done with the best of intentions but they have subjected native fish species to new competitors, predators or other agents that they are unable to withstand. The impacts of introduced fish species on aquatic biodiversity will fall into two broad categories i.e. ecological (includes biological and genetic effects) and socio-economic. The socio economic changes brought about by alien species in turn cause more ecological changes. Thus a reduction in native species may be from direct interaction with an exotic species or it may result from increased fishing pressure or changes in land use brought about by the presence of a newly established species (FAO, 1998).

Aquaculture is the major reason for introducing fish species to different countries. Of the 1205 introduction records of fish for aquaculture purposes, 607 (50 %) are reported as having been established in the

wild, 421 (35 %) are reported as not established and 177 (15 %) with unknown establishment (Fish base, 2003).

In Asia, there have been 406 introduction records, 176 (43.3 %) are reported as having been established in the wild and 152 (37.4 %) are reported as not established and 78 (19.2 %) with unknown establishment (Fish base, 2003). A species introduced for noble economic or aesthetic objectives may escape into the wild, invading native ecosystem with disastrous results: they become invasive alien species (IAS) (McNeely, 2001a.). Table-1 describes the detail of fish species introduced and their possible impacts on native freshwater fish diversity of Pakistan.

In the case where the direct cause of species extinction is identifiable, introduced species head the list (McNeely, 2001). Of the top ten freshwater aquaculture species in 2000 (FAO 2002), four (*Cyprinus carpio*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *Oreochromis niloticus*) led to adverse ecological effects in countries where they were introduced (Fish base, 2003). In Pakistan *Oreochromis mossambicus* was introduced from Malaya in 1951 (Naik, 1973). Whereas *Oreochromis aureus*, and *O. niloticus* were introduced from Egypt during the year 1985 under 1st aquaculture development program sponsored by Asian Development Bank.

The widespread introduction of alien fish species may pose significant ecological implications. These include the incorporation of species that may be in direct or indirect competition to endemic or native species in Asia's freshwater ecosystems (Pullin *et al.*, 1997).

The excessive fecundity and growth rate of alien

invasive species create pressure on the carrying capacity of the habitat (IUCN Bangladesh, 2000). Competition between the introduced species and native species is frequently cited as another cause of potential difficulty. The competition may be for food, or for breeding sites among nest-building species (Welcomme and Chavalit, 2003).

The present studies were conducted to investigate the status of native and alien fish fauna and impact of alien fish species on commercially important fishes in Punjab.

MATERIAL AND METHODS

The fisheries survey was carried out during 2001-03 at head works Balloki (River Ravi) and Trimmu (River Jhelum and Chenab) respectively by drag nets, cast nets and hand nets. The order of sampling of both the reservoirs was random. The fish collection was done by using gill nets with the same length (10 m) and height (1.6 m), but with meshes varying from 15 to 110 mm, knot to knot. Six samples were taken from each reservoir. Fishes were fixed in 10% formalin and then in 70% alcohol for further studies in the fish biology laboratory, University of the Punjab. Specimens were identified to species level using appropriate identification keys Mirza and Sharif, (1996) and Talwar and Jhingran (1991). Computation of data for richness, diversity and evenness of fish fauna was calculated by using a computer-based program SPDIVERS-BAS.

RESULTS AND DISCUSSION

The fish fauna diversity with capture count (table 1), richness, evenness and different diversity indices (table 2), and the analysis of the known introduced alien fish species in Pakistan has been given table 3

One of the most insidious threats to fish conservation around the world is deliberate or accidental introduction of fish species. Among the total eleven reported fish introductions in Pakistan *Oreochromis aureus* has completely invaded the Trimmu and Balloki freshwater reservoirs. *Oreochromis aureus* was introduced into freshwaters of Pakistan from Egypt under the first aquaculture development program funded by the Asian Development Bank for aquaculture in saline and brackish water bodies of Pakistan. Later on it was deliberately introduced in most of the freshwater bodies of Punjab and Sindh provinces.

The known intentional introductions in Pakistan include finfish (e.g. silver carp, China grass carp, tilapia, and rainbow trout) and shellfish for aquaculture and aquaria. Of these introductions, tilapia has escaped from aquaculture and has established on its own in many

wetlands in Sindh, while China grass carp, introduced in the 1970s into Haleji Lake for controlling weeds, has reportedly deprived the native 74 herbivorous fish of their food.

Oreochromis aureus is the most commonly found alien species in the Trimmu and Balloki reservoirs. The very high proportion of introduced *Oreochromis aureus* in catches from river Ravi is comparable to the diversity of *Oreochromis aureus* reported by Zahoor (2002). Measure for Shannon Wiener (1.333) and Simpson diversity index (0.912) for Balloki headworks respectively and (1.329 and 0.949 respectively) for Trimmu headworks that show dissimilar proportion of the richness of different fish species. Fish fauna at Balloki headworks (0.410) is less evenly distributed as compared to fish fauna at Trimmu headworks (0.906).

The economically important fishes of Pakistan (*Labeo rohita*, *Cirrhinus mrigala*, *Gibelion catla*,) are basically vegetarian or detritivorous, where as alien fish species *Oreochromis aureus*, *O. mossambicus*, *O. niloticus* are omnivorous that feed mainly on plankton and aquatic vegetation. *O. aureus* is a generalized feeder with a preference for detritus and decanted phytoplankton. It also eats small fish and fish larvae. The species is a maternal mouth brooder that constructs nests in shallow water for breeding and fertilization. For this reason, it is vulnerable to rapid changes in water level and depends on suitable substrates for nest building (Welcomme, and Chavalit, 2003)..

The Tilapia; *Oreochromis niloticus* has been the most widely introduced species in aquaculture (Fish Base 2003). It has played a significant role in the extinction of endemic cyprinids in Lake Lanao (Bleher, 1994). Tilapia are able to widely disperse as they are maternal mouth brooders, a single female can colonize a new environment herself by carrying her young in the mouth. The overall diversity for different fish species (Table-1) shows stable population of *O. aureus* both at Balloki and Trimmu reservoirs. McNeely *et al.* (2001b.) has reported that as a result of introduction of alien fish such as *Tilapia mosambica*, *Hypophthalmichthys nobilis*, *Ctenopharyngodon idella*, *Channa ssp.* and *Cyprinus carpio* all endemic lake fishes of the Philippines have been extinct. Due to wide ecological range alien *Oreochromis aureus* has been established in the freshwater reservoirs of Pakistan. This species is in direct competition for food to native herbivore fishes. *O. aureus* may pose serious adverse impacts in future on native fishes of Pakistan such as *Labeo rohita*, *Cirrhinus mrigala*, *Gibelion catla*, *Sperata sarwari*, *Rita rita*, *Channa marulius* and *Wallago attu* due to its competition for food, breeding grounds, predation and habitat alteration. The impact of alien freshwater fishes to population structure, biodiversity level, food chain, structure of aquatic animals, especially fish in freshwater ecosystems is not small (Guozhang Liao, 1998).

Table 1. Status of fish fauna at Head Balloki (River Ravi) and Head Trimmu (River Jhelum and Chenab).

Scientific Names	Local/ common	Ravi	Jhelum
<i>Gudusia chapra</i> (Hamilton)	Palli	8	6
<i>Notopterus notopterus</i> (Pallas)	Pari,But	2	3
<i>Labeo calbasu</i> (Hamilton)	Di,Kalbansu,Kalu	11	1
<i>Labeo gonius</i> (Hamilton)	Seereha	30	-
<i>Labeo rohita</i> (Hamilton)	Rohu,Dambra	93	1
<i>Labeo dero</i> (Hamilton)	Challi	82	-
<i>Labeo dyocheilus pakistanicus</i> Mirza and Awan	Pakistani torki	14	-
<i>Cirrhinus mrigala</i> (Hamilton)	Mrigal,Mori	41	1
<i>Cirrhinus reba</i> (Hamilton)	Reba,Sunni	102	10
<i>Gibelion catla</i> (Hamilton)	Thaila	3	2
<i>Ctenopharyngodon idella</i>	China rohu	43	11
<i>Amblypharyngodon mola</i> (Hamilton)	Mola,Chilwa	29	11
<i>Aspidoparia morar</i> (Hamilton)	Common chilwa	18	10
<i>Systemus sarana</i> (Hamilton)	Jundoori	11	-
<i>Puntius chola</i> (Hamilton)	Chola barb	43	-
<i>Puntius ticto</i> (Hamilton)	Rittatus,Popra	36	9
<i>Puntius sophore</i> (Hamilton)	Sophore popra	439	12
<i>Puntius conchoniis</i> (Hamilton)	Rosy barb	7	-
<i>Crossocheilus diplocheilus</i> (Heckel)	Dogra	16	-
<i>Garra gotyla</i> (Gray)	Pather chat	2	-
<i>Osteobrama cotio</i> (Hamilton)	Palero	40	14
<i>Chela cachius</i> (Hamilton)	Bidda	11	-
<i>Salmophasia bacaila</i> (Hamilton)	Small chal	36	9
<i>Salmophasia punjabiensis</i> (Day)	Punjabi chal	9	2
<i>Securicula gora</i> (Hamilton)	Big chal	4	3
<i>Esomus danricus</i> (Hamilton)	Soomara	3	-
<i>Barilius modestus</i> (Day)	Lahori chilwa	40	-
<i>Barilius vagra</i> (Hamilton)	Lahori chilwa	37	-
<i>Sperata sarwari</i> Mirza, Nawaz and Javed	Singharee	1	1
<i>Mystus cavasius</i> (Hamilton)	Tingara	8	3
<i>Mystus bleekeri</i> (Day)	Bleekri tingara	21	-
<i>Mystus vittatus</i> (Bloch)	Keenger fish	43	6
<i>Rita rita</i> (Hamilton)	Tirkanda	1	-
<i>Heteropneustes fossilis</i> (Bloch)	Singhi	18	-
<i>Ompok bimaculatus</i> (Bloch)	Pallu,Pafta	23	-
<i>Ailia punctata</i> (Hamilton)	Pootals	3	2
<i>Clupisoma garua</i> (Hamilton)	Bachwa	5	1
<i>Eutropiichthys vacha</i> (Hamilton)	Jhalli	2	8
<i>Pseudotropius atherinoides</i> (Bloch)	Pootlas	1	-
<i>Xenentodon cancila</i> (Hamilton)	Cowa tokia, Kan	1	1
<i>Channa punctata</i> (Bloch)	Daula,Guddu	59	1
<i>Sicamugil cascasia</i> (Hamilton)	Gachkigura	2	5
<i>Chanda nama</i> Hamilton	Sheesha	45	2
<i>Chanda ranga</i> Hamilton	Ranga sheesha	64	-
<i>Chanda baculius</i> Hamilton	Baculius sheesha	16	-
<i>Glossogobius giuris</i> (Hamilton)	Guloo	4	3
<i>Colisa fasciata</i> (Bloch)	Chidu,Kangee,Fider	67	-
<i>Colisa lalia</i> (Hamilton)	Choti kangee	16	-
<i>Oreochromis aureus</i> Steindachner	Golden tilapia	169	14
<i>Macrognathus pancalus</i> Hamilton	Groj	3	16
<i>Mastacembelus armatus</i> Lacepede	Bam	-	2

Table: -2. Results for diversity, richness and evenness at Head Balloki (River Ravi) and Head Trimmu (River Jhelum and Chenab).

RIVER	RICHNESS	SHANNON DIVERSITY	SIMPSON INDEX	EVENNESS
Ravi	50	1.333	0.912	0.410
Jhelum	30	1.329	0.949	0.906

Table-3:-Analysis of the known introduced Alien fish species in Pakistan

Fish Species	Year of Introduction	Reference	Reason for Introduction	Possible Impact on Native fish fauna	Status
Common carp <i>Cyprinus carpio</i> (Linn.) Three varieties were reported from Mangla lake C. <i>carpio specularis</i> , <i>C. carpio communis</i> and <i>C. carpio nudus</i>	1964 from Thailand and UK.	FAO (1997) in FISHBASE, 2003.	Aquaculture, sport fishing	Reduction of water quality and destroys aquatic vegetation by uprooting it, feed on eggs of native fishes, Potent breeder, compete for food and space with native fauna of Pakistan both in captivity and wild. Their habit of digging around in the bottom and muddying the water can seriously alter the environment to the detriment of other species	Established/ invasive
Grass carp <i>Ctenopharyngodon idella</i> (Val.)	1 st introduction 1964 Canton, China, reintroduced in 1974-75	FAO (1970)	Aquaculture, biological control of aquatic weeds	Destruction of water quality, feed voraciously on aquatic vegetation that act as shelter and breeding ground for most of the native fishes, invertebrates, amphibians. Competition for food and marketing.	Established/ invasiveness not confirm
Bighead carp <i>Hypophthalmichthys nobilis</i> (Richardsons)	1982-1983 from Nepal, China	FAO (1997), Mahboob and Sheri (1997)	Increase production, angling, sport, and aquaculture.	Competition for food and space, The species feeds primarily on phytoplankton.	Not established / invasiveness not confirm
Silver carp <i>Hypophthalmichthys molitrix</i> (Richardson, 1845)	1964	FAO (1970)	Increase fish production, angling, sport, aquaculture	Competition for food and space in captivity especially with <i>Gibelion catla</i> The species feeds on detritus and phytoplankton and may compete with species of similar habit in the wild.	Not established / invasiveness not confirm
Tilapia <i>Oreochromis aureus</i> (Steindachner)	1985 from Egypt	De Silva, <i>et al.</i> , (2004)	Aquaculture in brackish / saline water bodies	Potent breeder, compete for food and space with native fauna of Pakistan both in captivity and wild. Welcomme, R. and Chavalit V. 2003	Established / invasive
Tilapia <i>Oreochromis mossambicus</i> (Peters)	1951,1954 from Indonesia, Egypt, Thailand	Naik, I.U., (1973)	Aquaculture in brackish / saline water bodies	<i>O. mossambicus</i> is notorious for forming dense populations of stunted fish, particularly in brackish and small canals and lakes. <i>O. mossambicus</i> is a generalized feeder with a preference for detritus and decanted phytoplankton. It also eats small fish and fish larvae. The species is a maternal mouth brooder that constructs nests in shallow water for breeding and fertilization. Welcomme, R. and Chavalit Vidthayanom (2003).	Established / invasive
Tilapia <i>Oreochromis niloticus</i> (Linnaeus)	1985 from Egypt	De Silva, <i>et al.</i> , (2004)	Aquaculture in brackish / saline water bodies	It eats detritus and can feed on small fish and fish larvae. The species is a maternal mouth brooder that constructs nests in shallow water for breeding and fertilization. For this reason it is vulnerable to rapid changes in water level and depends on suitable substrates for nest building. Welcomme, R. and Chavalit Vidthayanom (2003).	Established / invasive
Gold Fish <i>Carassius auratus</i> (Linnaeus)	1961	Mirza, M.R., (2003)	Aquaculture, Ornamental	Competition for food and space with native fauna of Pakistan in the wild.	Established
Mosquito fish <i>Gambusia affinis</i> (Baird and Girard).	Not known	Not known	Biological control of mosquitoes	It feeds on eggs on larvae of other fish. Damage to fish stocks	Established

All over the world the alien invasive species have been identified as an agent of loss of native biodiversity, the adverse effects were not considered

while introducing alien species.

IUCN Pakistan (2004) has also analyzed the threat factors for native fish fauna from vulnerable to

near critically endangered and has suggested the rehabilitation of habitat and endangered native fish species. The alien species negatively impact native species through trophic alteration (predation, competition, food web alteration) including introduction of diseases, parasites aggressive effects and overcrowding (Taylor *et al.*, 1984). The common carp has been considered as a pest because of its abundance and its tendency to reduce water clarity, destroy and uproot aquatic vegetation, used as habitat by a variety of aquatic species (FAO, 1970). In United States the habitat alteration was the factor that affected most species but the introduction of alien invasive species was also an important factor (Lassuy, 1995).

The impact of alien invasive sport fish is for the most part unpredictable in time and space, with the introductions of relatively few species having resulted in many extirpations of indigenous fish species worldwide (Cambray, 2003). One third of 432 fish species in Yunnan are threatened or even extinct for the reasons of over fishing, dam construction, water pollution. But blind introduction of alien species is one of the most important factors reducing the number of native fish species (Chen *et al.*, 1989).

A substantial proportion of Canada's freshwater fish and mollusks are at risk for a variety of reasons. Habitat alteration, pollution and alien invasive species are the dominant threat factors influencing species at risk in Canada (Alan *et al.* 2006). According to IUCN Bangladesh (2000) the alien invasive species of fish were prescribed only for restricted cultivation in closed ponds; but this strategy proved futile by way of repeated flooding. Resultantly, fate of 54 indigenous species of fish in Bangladesh has become threatened and many of them may become extinct if the process continued.

Alien invasive species can negatively impact native species and fundamentally alter aquatic ecosystem through trophic alterations (predation, competition, food web alteration), the introduction of disease and parasites, habitat alterations, and spatial alterations (aggressive effect and overcrowding) (Taylor *et al.*, 1984b).

The federal and provincial fisheries authorities should take into consideration the unchecked introduction of alien fish species and no species should be introduced without evaluating their detailed life history and probable impacts on the native fauna. It is high time that fisheries authorities in Pakistan may improve the existing policies to save the native fish diversity from extinction affected by adverse impacts of habitat destruction and alien invasive species.

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