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Bio-invasion of exotic fish tilapia (*Oreochromis mossambicus* P. 1852) in Lake Jaisamand, India

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Abstract
The tropical freshwater cichlidae fish, Tilapia (*Oreochromis mossambicus* Peters, 1852) is suitable for any aquatic ecosystems due to its adaptable life history, prolific reproduction, maternal care and ability to tolerate adverse environmental conditions. Tilapia is worldwide fish species and due to its potential and affordability it is considered as aquatic chicken. In the present study population structure of exotic fish tilapia and its impact on indigenous ichthyofauna of Lake Jaisamand (India) is described. Results show that fish production and community structure of local fish fauna were adversely affected by high density and abundance of this exotic fish species tilapia. During 1990-91 fish production was 287 metric tons which was composed by Indian major carps (37%), minor carps (54%) and catfishes (9%) but due to invasion of tilapia it was reduced 105 mt till 1996-97 and fish production composition was changed and it is contributed by Indian major carps (14%), minor carps (3%), catfishes (30%) and tilapia (54%). The reduction of indigenous fauna was continuous and it is noted that contribution of Indian major carps were only (11%), minor carps (3%), catfishes (4%) and tilapia dominated by 82% out of total production 119 metric tons (2012-13). The aquatic environment of lake was very suitable for tilapia and its growth in terms of length/weight was minimum 25.0 cm / 400 g and maximum 43.5 cm / 1620 g during 1997. It shows the stunted growth due to high density and observed 17.5 cm / 98 g minimum and 38.0 cm / 932.5 g maximum during 2013. Study revealed that tilapia is highly invasive due to high abundance and competitive for food and space to Indigenous fish fauna. It is also recommended that there is need of detailed studies on tilapia abundance, recruitment and local environmental conditions to understand the invasion potential and consequences for the endemic aquatic biodiversity.

Keywords: Exotic fish, tilapia, invasion, indigenous fauna, Jaisamand Lake, Reservoir.

1. Introduction
Jaisamand Lake is the largest man made freshwater Lake and considered one of the most productive water body of India. It was constructed in 1729 AD across the Gomati River in the southern Rajasthan and its geographical location is 73° 57' E longitude and 24° 14' N latitude at an altitude of 587 m (MSL). The age old existence, specific morphometric features and water quality profile of this lake provide opportunities for the high biological production (Durve, 1976, Ujjania, 1997, Kohli *et al.*, 1998 and Balai, 2007) [11, 32, 16, 6]. Sharma and Johal (1982) [23] also reported 41 fish species in this lake.

The exotic fish was noticed in Jaisamand Lake during 1991 (Anon, 1995) [2] and it was identified as Tilapia (*Oreochromis mossambicus*, Peters 1852). This exotic fish tilapia or the Mozambique tilapia is an African mouth-brooder cichlid native to the rivers of central and southern Africa (Philippart and Ruwet, 1982 and Trewavas, 1982) [21, 30] and due to its aquacultural utility it is widely distributed around the world (Philippart and Ruwet, 1982 and Arthington *et al.*, 1984) [21, 3]. As occurrence of this exotic fish species tilapia neither reported in upstream, downstream nor in vicinity of Lake Jaisamand earlier, probably it accidentally entered during the stocking of Indian major carp seeds which was brought from out of the state resources. Introductions of exotic fishes by deliberately or accidentally is considered always risky for the native fish fauna. Interactions of non-native with native fish species is likely to threat to fish biodiversity due to modification of habitat (Miller *et al.*, 1989 and Harrison and Stiassny, 1999) [18, 14]. Moreover, Tilapias being omnivore in feeding habit directly compete for food with other fishes. Thus, populations of native fish may be affected by non-native species due to competition for resources, predation, habitat modification, water quality alterations, hybridization, parasites importation and diseases (Moyle *et al.*, 1986, Arthington, 1991 and Canonico *et al.*, 2005) [20, 3, 8]. Canonico *et al.*, 2005 [8] also reported that invasion of exotic

populations are causing environmental and ecological problems in many countries and the tilapia (*O. mossambicus*) is included in Global Invasive Species Database (2006) in top 100 invasive alien species on the planet. Moyle, 1976 [20] reported that introduction of *O. mossambicus* and *Tilapia zilli* in California reservoir has affect the native ichthyofauna. The invasion of alien fishes is potentially serious threat to the indigenous fish faunas (Singh and Lakra, 2011) [25] and negative effects of introduced species are widely recognized (Gupta and Jain 1994, Sugunan 1994, Canonico *et al.* 2005, Singh and Lakra 2006, Lakra *et al.*, 2008, Arthur *et al.* 2010, Ahmad *et al.* 2010, Singh and Lakra 2011, Ganie *et al.* 2013 and Ujjania *et al.* 2013) [13, 29, 8, 24, 17, 5, 1, 25, 12, 31].

This study elicited the potential effects of introduced tilapia species on native biodiversity which is informative for the fish biologist, aquaculturists, natural resource managers and other groups who are interested in culture or introduction of tilapias.

2. Materials and Methods

This study was carried out during the 1996-97 and 2012-13 in Lake Jaisamand. For the investigation 550 specimens were used to measure for morphometric data including total length (TL, mouth tip to end of caudal fin), standard length (SL, mouth tip to caudal peduncle) were measured in centimeter with the help of measuring tape precise of ±0.5 cm and weight (WT) was taken in grams with help of single pan balance precise of ±50 g from the landing center (Namla) of Jaisamand Lake (Fig. 1). The annual fish production data (1990 to 2013) of Jaisamand Lake was collected from Department of Fishery (Rajasthan Govt.), Udaipur.

3. Result and Discussion

The aquatic environment of Jaisamand Lake for tilapia was favorable because it was observed that the body size of tilapia in the commercial catches of lake was very good. It was noted that minimum and maximum length/weight was 25.0 cm / 400 g and 43.5 cm / 1620 g recorded during 1997 while it was stunted 17.5 cm / 98 g and 38.0 cm / 932.5 g during 2013 respectively. It shows continuously fall in size due to high abundance of tilapia population. Sreenivasan (1967) [28] reported the size of tilapia 480-1000 g from Mani Mutthur and Amaravathi reservoirs in South India. The average size of tilapia from Tamil Nadu reservoir was 1.5 kg during the 1960s with the minimum size of 500 g and similarly, tilapia weighing 2.5 kg was very common in Malampuzha reservoir, Kerala during the 1960s, with an average size of 1.5 kg to 1.75 kg but its size was stunted (0.5 to 0.7 kg) in Malampuzha during 1994 (Sugunan, 1994) [29]. Pullin, (1988) [22] also reported that tilapia now fallen out of favor as a preferred aquaculture species because of their 'stunt' propensity and poor quality due to the small size.

The fish landings of Jaisamand Lake was composed by Indian major carps (*Labeo rohita, Catla catla, Cirrhinus mrigala, Labeo calbasu*), Minor carps (*Cirrhinus reba, Puntius sophore, Puntius ticto, Puntius ranga*), Catfishes (*Channa striatus, Mystus tengra, Notopterus notopterus*) and Miscellaneous including tilapia (*Mastacembelus armatus, Gudusia chapra, Chanda nama, Glossogobius giuris, Parambassis ranga, Oreochromis mossambicus*). Tilapia was restricted to only few specimens in daily catch during 1990 but subsequently catch composition was change and its dominancy trend was observed in the fish production (Fig. 2). During the 1990-91 fish production was 287 mt and catch was composed of Indian major carps 37%, minor carps 54% and catfishes 9% (Fig. 3) but during 1996-97 it was reduced 105 mt which was composed by Indian major carps 14%, minor carps 3%, catfishes 30% and tilapia 54% (Fig. 4). During 2012-13 dominancy of tilapia was increased, it was 82% of total fish production 119 mt and remaining 18% of composed by Indian major carps were only 11%, minor carps 3%, catfishes 4% (Fig. 5). The result depicted that tilapia dominated and virtually eliminated all other indigenous fishes including major carps, minor carps including endemic fish *Labeo rajasthanicus (icar)*, catfishes and so many other fishes in Lake Jaisamand. Similar findings were also reported by (Jhingran 1991, Sugunan 1994, Lakra *et al.* 2008, Singh *et al.* 2010b and Ganie *et al.* 2013) [15, 29, 17, 26, 12]. Sugunan (1994) [29] reported that Vaigal, Krishnagiri, Amaravathi, Upper and Pambar reservoirs in Tamil Nadu are harboring sizable population of tilapia, since 1960s contributing substantially to commercial catches. In Krishnagiri, the exotic fish change the scenario on account of competition with the mullet (*Rhinomugil corsula*) from the predominant position in the 1960s the percentage of tilapia came down to 4.3% only in 1983-86, to increase in the year 1989-90 to 68% (Jhingran, 1991) [15]. In Jaisamand the fish production fluctuation due to contribution of tilapia suggest simultaneous visible impact on the total production of the Indian major carps and catfishes as evident from the observations of (Gupta and Jain 1994, Singh 1994, Ujjania 1997, Ujjania *et al.* 2004 and Durga & Srivastava 2008) [13, 27, 32, 33, 10]. Similarly, decrease in population size of established fishes due to overcrowding of tilapia were also reported by Courtenary and Hensley (1979) [9] and Bhagat and Dwivedi (1988) [7].

For controlling Tilapias in Jaisamand certain remedial measures such as selective fishing and even under sized tilapias removal were practiced with special permission from the state Fisheries Department. Similarly, for few years catfish catching was stopped and Indian major carps fingerlings was stocked in adequate numbers. These controlling measures observed good recovery in the production of IMC and other indigenous fishes, however, in the recent years resurgence of tilapia and it is dominating the catch once again which requires attention for control by appropriate means.

Fig 1: Map of study area

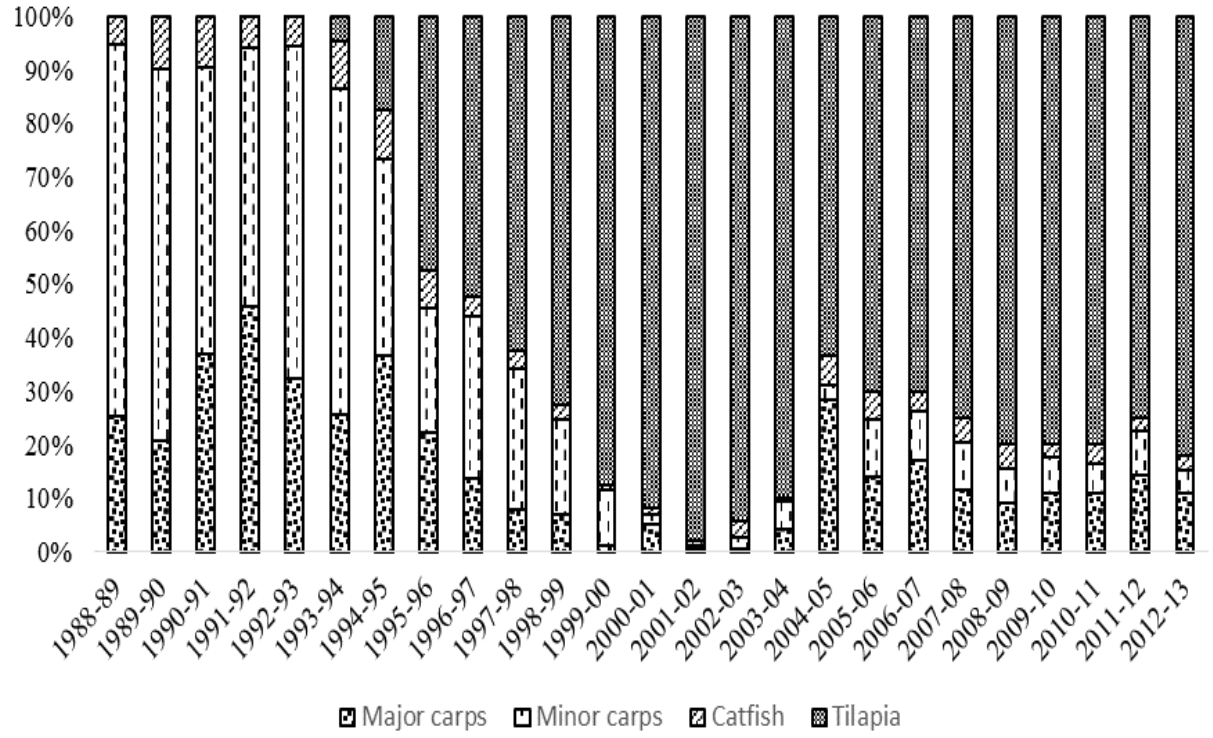

Fig 2: Fish catch composition of Jaisamand Lake

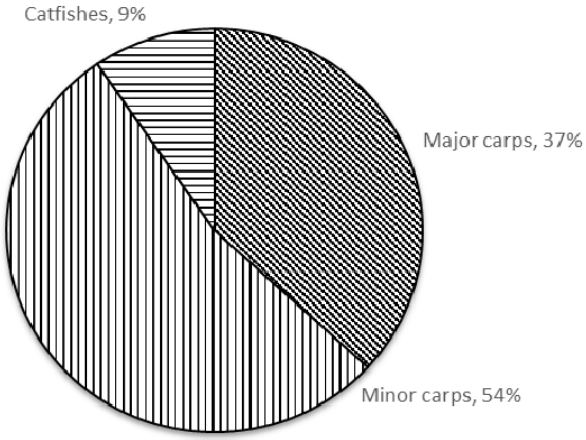

Fig 3: Catch composition of Jaisamand Lake during 1990-91

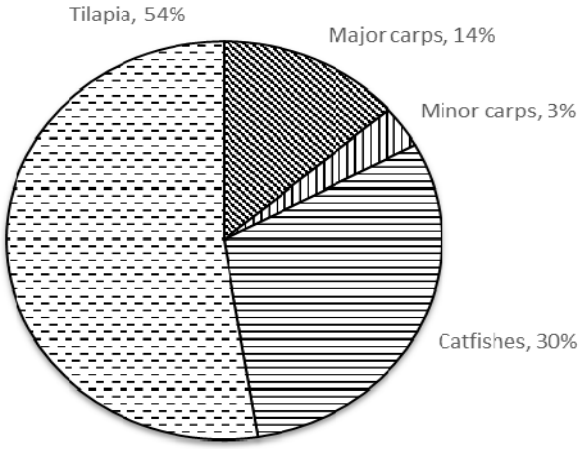

Fig 4: Catch composition of Jaisamand Lake during 1996-97

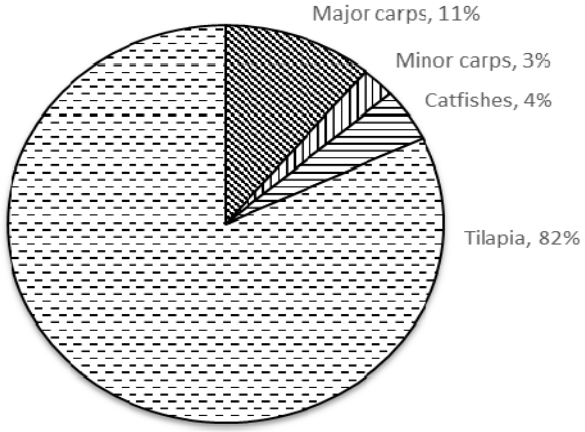

Fig 5: Catch composition of Jaisamand Lake during 2012-13

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