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Congenial aquatic environment and population establishment of exotic fish tilapia (*Oreochromis mossambicus* P. 1852) in Jaisamnd Lake, India

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Abstract

Environmental conditions of aquatic resources and their suitability play a major role in growth of fishes including non-native species also. Tilapia, (*Oreochromis mossambicus*) is not a native fish but well adapted to the prevailing local ecological and edaphic conditions of lake Jaisamand, India. The results show that 4 length groups and 4 age classes were observed in the catch which were dominated by large size by length 30-37 cm (67%) and by age 3+ (60%). The dominance of large sized tilapia in the catch is indication of favorability or congeniality of aquatic environment for tilapias in Jaisamand Lake. The growth of fish was inversely related to the age and observed 11.69 cm at 1+ age, 8.67 cm at 2+ age, 7.89 cm at 3+ age and 6.15 cm at 4+ age of fish. It is observed that growth rate of tilapia was better and satisfactory in Jaisamand Lake which is reasoned for efficient use of available food resources by these fishes. The catch composition of tilapia further shows that contribution of tilapia was 0.1% during 1991-92 while it increased up to 98.0% during 2001-02 but declined to 75.0% during 2011-12. This period after 1991-92 represents the invasion and subsequent establishment of tilapias in Jaisamand Lake. Further, the catch composition showed that indigenous fish fauna was adversely affected by such establishment and invasion of tilapia which resulted into a visible decline of age old fisheries of Indian major carps (0.06%), minor carps (0.4%) and catfish (1.0%).

Keywords: Jaisamand Lake, tilapia, invasion, population establishment, fish growth

1. Introduction

Fishery resources are important source of economic activities for the nation and social development. Reservoirs are the single largest inland fishery resources for tapping the production potential^[1]. Aquatic ecosystems influence the size, age and growth of the fishes which shows the congeniality of resource^[2]. Jaisamand Lake is one of the largest and most productive water body of India^[3]. The specific morphometric features and water ecological profiles of this lake support for high biological production^[4, 5, 6].

Tilapia (*Oreochromis mossambicus*, Peters 1852) is cichlid fish and native of central and southern African rivers^[7, 8]. High aquacultural utility of this fish is the main reason for its worldwide distribution^[9]. Interactions of this non-native fish with indigenous fishes is likely to threaten the fish biodiversity due to modification of habitat^[10,11] and competition for space, predation, habitat modification, water quality alterations, hybridization, parasites importation and diseases^[12, 13]. Moreover, environmental and ecological problems are also reported to occur by the exotic fishes^[14]. Probably for these reasons tilapia (*O. mossambicus*) is included in Global Invasive Species Database (2006) and occupies place among the top 100 invasive alien species. The invasion and establishment of non-native fishes is considered a serious threat to the native fish fauna^[15] and adverse effects of exotic fish in different water bodies are also recognized by^[2, 16, 17, 18, 19, 20, 21].

Jaisamand has been considered as an important water resource for supporting a lucrative fisheries of Indian major carps. However, in this water body exotic fish tilapia was first time observed in fish landings during 1991^[22]. Further, it is reported that fish production and catch composition from this water body are adversely affected by the invasion of tilapia^[23]. This study has attempted to elucidate an analysis of catch composition to collect comparative information on population establishment, size and growth of exotic fish tilapia (*O. mossambicus*). The growth performances of various age/size groups and their impacts on commercially important native fishes are also evaluated.

2. Materials and Methods

2.1 Study area

Jaisamand is the largest man-made freshwater lake which was constructed in 1729 AD across the Gomati River about 56 km away in South East of Udaipur city in southern Rajasthan

(Fig. 1). The geographical location of Jaisamand Lake is $73^{\circ} 57'$ E longitude and $24^{\circ} 14'$ N latitude at altitude of 587 m (MSL). This lake is having a water spread of 7,160 ha, and maximum depth of 32 m and mean depth of 15 m.

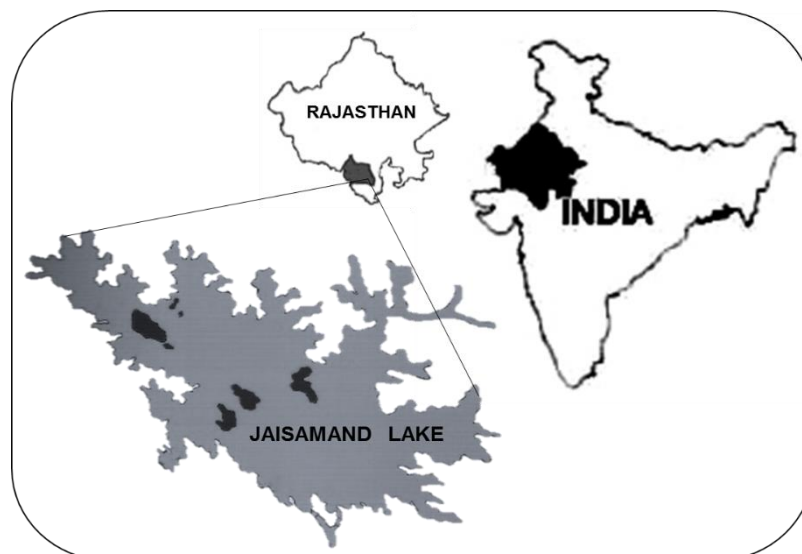


Fig 1: Map of study location (Jaisamand Lake)

2.2 Sample Collection and analysis

The growth rate of the tilapia was estimated by scale method because it is known to reflect the authentic alterations in the growth of fish with the advancing age of fish. Similarly, growth can also be represented by the calculating mean length and weight of different age groups of the fish.

For the age and growth study, scales and morphometric data (total length, standard length, weight etc.) were randomly collected from 90 fish specimens from commercial landing center of Jaisamand Lake during the fishing year 2012-13. These key scales were preserved in small paper envelopes with essential information of fish i.e. total length (cm), standard length (cm), weight (g), date of collection etc. For the age estimation these scales were dipped in 1 % KOH solution for 5-10 minutes and gently washed with tap water to remove extraneous matter. Thereafter, such cleaned scales were used to examine annual growth marks on the scale [24, 25] under 4P scale reader.

Total length (cm) of the fish was measured from tip of snout to the end of caudal fin and collected length data were grouped at 7.0 cm length intervals and number of grouped fishes were converted into percentage for estimating the size and their contribution in the catch of the fish.

The annual fish production data from 1991-92 to 2011-12 for Jaisamand Lake were collected from Department of Fisheries (GOR), Udaipur assessing relative contribution of tilapia in the total fish production.

3. Results and Discussion

The observed total length of tilapia varied 17.5-38.0 cm and maximum exploitation (67%) was observed in 30.0-37.0 cm length group and minimum (7.0%) was recorded in 38.0-45.0 cm length group. The remaining length groups 15.0-22.0 cm and 22.0-30.0 exploited with 13.0% for each (Fig. 2 A). The scale based age study shows 1+, 2+, 3+ and 4+ age classes and 10%, 17%, 60% and 13 % contribution respectively (Fig. 2 B). The aquatic resources are efficiently used by large fishes and considered as the key measure in population studies [2]. Moreover, large fishes consume more oxygen per unit time

[26]. The results of present study show that tilapia population contributed by large sized fishes which is a valid sign of congenial aquatic environment of Jaisamand Lake for tilapia. Thompson [27] and Cucherousset [28] stated that large sized fishes modify the trophic structure of recipient communities. Similar findings are also reported for tilapia in the Ganga river system [2] and in Jaisamand Lake [29].

In the present study, age composition of tilapia varied from 1+ to 4+ age classes and calculated length was 11.69 ± 0.28 cm, 20.36 ± 0.40 cm, 28.24 ± 0.50 cm and 34.39 ± 1.16 cm for respective age classes in the Jaisamand Lake. From these observations it can be inferred that growth increment was inversely related to age of tilapia as it was maximum 11.69 cm at 1+ age group while minimum 6.15 cm at the age of 4+ (Table 1). The results of the present study depict that growth rate of tilapia was appreciably high which indicated that fishes had excellent ability to use available resources very efficiently. Growth increments of fish is natural process and it is affected by aquatic environment and habitat [30, 31, 32].

The catch composition data of Jaisamand Lake vividly indicate that tilapia was first time observed in fish catch during 1990-91 and its invasion as well as population expansion in the subsequent years suppressed the population of indigenous fish particularly Indian major carps. Interestingly, during 1991-91 the relative contribution of major and minor carps was 288.93 mt (94.2%), catfishes it was 14.32 mt (5.7%) and however, tilapia was mere 0.25 mt (0.1%). But after invasion and population expansion the contribution of tilapia was increased up to 343.94 mt (98.0%) and 504.75 mt (75.0%) during 2001-02 and 2011-12, respectively. Thus, by this time population of tilapia were well established and dominated the fish catch by suppressing other commercially important indigenous fishes (Table 2 and Fig. 3). Similarly, it was described by Mayank and Dwivedi [2] that native fishes (*Tor mahseer*, *T. tor* etc.) was dramatically declined after invasion of *O. niloticus* and *C. carpio* in the Paisuni river due to food and space crisis. Such decline in the population of commercially important

indigenous fishes due to invasion of alien fishes has also

reported in the rivers of Vindhyan region of India [33].

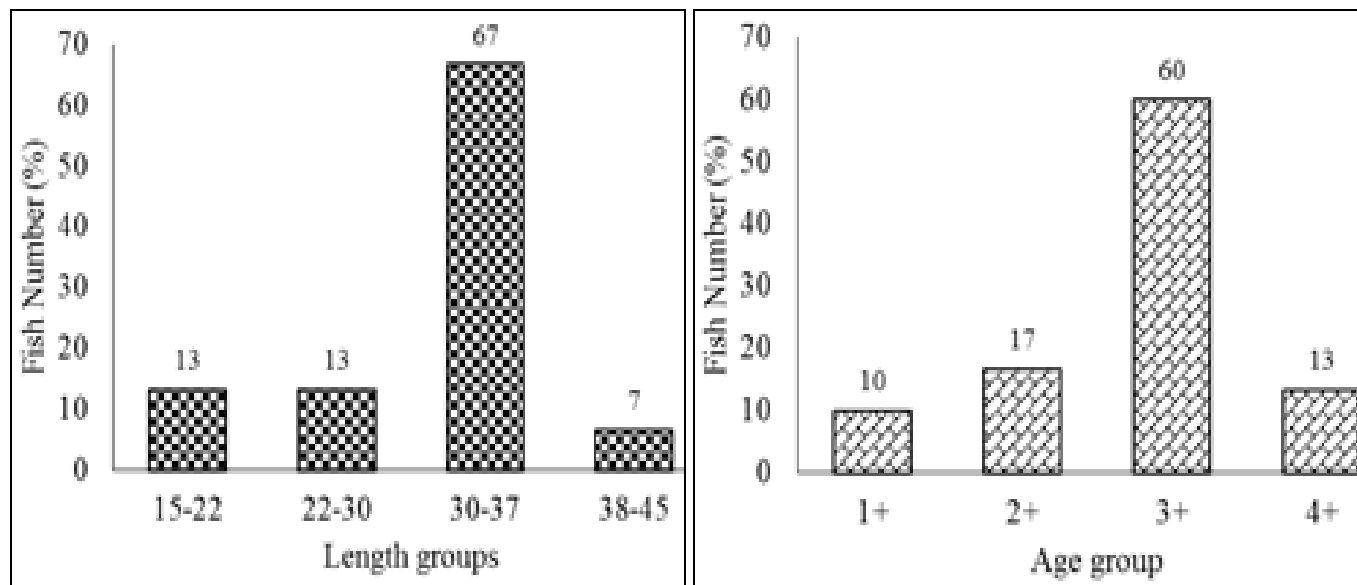


Fig 2: Length and Age composition of tilapia in Jaisamand Lake

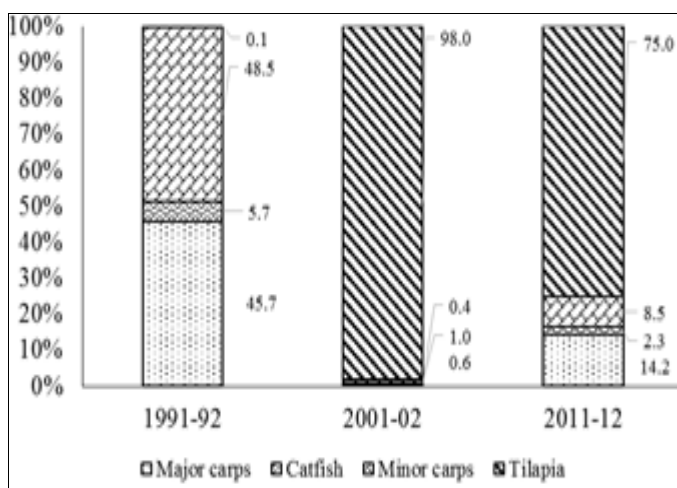


Fig 3: Tilapia contribution in fish production of Jaisamand Lake

Table 1: Age and growth rate of tilapia from Jaisamand Lake

Age	Calculated Length (cm)			Growth rate (cm)
	Minimum	Maximum	Mean ± SE	
1+	08.18	14.52	11.69 ± 0.28	11.69
2+	16.25	24.32	20.36 ± 0.40	08.67
3+	24.36	32.70	28.24 ± 0.50	07.89
4+	32.24	36.85	34.39 ± 1.16	06.15

Table 2: Contribution of tilapia in total fish production of Jaisamand Lake

Year	Fish production (metric tonnes)				Total
	Major carps	Catfish	Minor carps	Tilapia	
1991-92	115.93 (45.7%)	14.32 (5.7%)	123.00 (48.5%)	0.25 (0.1%)	253.51 (100.0%)
2001-02	2.18 (0.6%)	3.47 (1.0%)	1.37 (0.4%)	343.94 (98.0%)	350.96 (100.0%)
2011-12	95.48 (14.2%)	15.69 (2.3%)	57.18 (8.5%)	504.75 (75.0%)	673.10 (100.0%)

4. Conclusion

The aquatic environment of Lake Jaisamand was fairly congenial for survival, breeding and growth performances of

tilapia which is further confirmed by the presence of elder sized (length and age) tilapia in the fish population as evident from their sizeable share in total fish catch of the water body during this study. Appreciably high fish growth rate of tilapia is also evident from the non-polluted and moderately eutrophic aquatic environment of Jaisamand Lake. Furthermore, it is also concluded that commercially important indigenous fishes were adversely affected by the invasion and establishment of the Tilapia in the lake Jaisamand.

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