

# Resource Use Efficiency and Invasive Potential of Non-Native Fish Species, *Oreochromis niloticus* from the Paisuni River, India

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## Abstract

*Oreochromis niloticus* species are adapted to their own set of local ecological and climatic conditions from the Paisuni river, India. Consequently, environmental conditions and their connectivity to organisms may play a big role in generating growth outcome of non-native species in natural conditions. Study was undertaken during the period of October 2015 to September 2016 from the Paisuni river, India. Invasive potential of *O. niloticus* was measured through size composition, age and growth from the Paisuni river. The total length of fishes varied from 96 to 398 mm with 0+ to 6+ age groups. Their size groups and age groups indicated that the *O. niloticus* are well stable in the Paisuni river. Their stock and density from the Paisuni river are helping to fisher community for their livelihood and malnutrition as well as poor men malnutrition. The maximum growth increment was observed in 1+ age group (145 mm) and minimum in 6+ age groups (14 mm). The growth of fishes very systematically declined after 1+ age group in the Paisuni river. The maximum fishes were exploited in 241 to 270 mm size group with 18.39%. These sizes of fishes are very attract and magnetize to the fishers from the Paisuni river.

**Keywords:** Non-native fish; *Oreochromis niloticus*; Age and growth; Mahseer; Food web

## Introduction

Fishery resource operation is the chief and economic activities globally. Fishes are the top consumers in aquatic ecosystems and their size, age and growth can be used as an indicator of resource use efficiency and invasive potential of fishes in the ecosystems. Nile tilapia, *Oreochromis niloticus* is a non-native fish species for India. Non-native species continue to be altering the function and structure of the ecosystems globally [1-5]. *O. niloticus* is a very fast distributing fish species in Indian riverine ecosystems [6-8]. Riverine fisheries play a significant role in the livelihoods of fishermen communities [9-13] and other persons which are involved in fishery sector [14]. Paisuni river is a tributary of the Yamuna river and the Yamuna river is tributary of the Ganga river. Ecological conditions of the Ganga basin rivers (the Ganga river and its tributaries) are poor and contaminated with heavy metals such as copper, chromium, lead mercury and zinc [15-19]. These metals are damaging reproductive cycle, life-history of fishes and productivity of the river [20,21].

Invaded non-native fish species can cause significant adverse impacts on ecosystems as like food web and ecosystem functioning [22] and ecological damage [23]. It can play critical roles in the function of their ecosystems [22,24]. It exerts competition pressures on native fishes and other aquatic organisms [25]. These fishes also play important role for food security and livelihood for fishers of the Paisuni river. The Paisuni river is drain in undeveloped and low income community of Vindhyan region [26]. The Paisuni river has very important fish species, Tor mahseer (Tor tor). The purpose of this study was to conduct comparative information of size and growth data of *O. niloticus* from the Paisuni river and available growth data of different geographical region which gives a mega information of their resource use efficiency and invader potential in new ecosystem.

## Materials and Methods

Study was undertaken during the period of October 2015 to September 2016 in the Paisuni river, India. The Paisuni river is a perennial river. It arises at 275 m above sea level (m asl) in the Kaimur hills of Vindhyan range and flows ca. 100 km north across

the Bundelkhand Plateau to meet the Yamuna river at 80 m asl. The stony substrate occurred from upper and middle stretch while silt-clay-sand at lower stretch [27]. Water levels are found lowest during May-June and highest during July to September, when a 3-5 meter rise in water level forms a broad channel of the River. For the purpose of collection of data on fish size and scale (for age determination) from Karwi wholesale fish market was preferred. Karwi fish market is just by the right side of the Paisuni river and major part of fish catch from the lower stretch of the river is brought to this market for selling. Fishing was conducted by local fishermen with the help of using drag net, gill net, cast net, scoop net and hook and line. Total length (TL) of fishes was measured from tip of the snout to the largest fin rays of caudal fin. Collected data were classified at 30 mm intervals for estimation of size group and exploitation frequency of fishes. The number of samples calculated according to size group and converted into percentage. 34 samples were collected per month while 408 samples were collected for the present study.

The scale method has been used in the present investigations, as scales reflect faithfully changes in rate of growth and other valuable life history information. The key scales were removed from the row above lateral line below dorsal fin region [28,29]. The scales were cleaned in 5% KOH solution to remove adhering- tissues and finally washed in distilled water. The scales were then pressed while drying in order to avoid their curling. The growth of fishes were measured individually in mm. The all measured fishes were arranged according to age wise and calculated mean length for that age groups. The mean length of individual age groups represented that growth.

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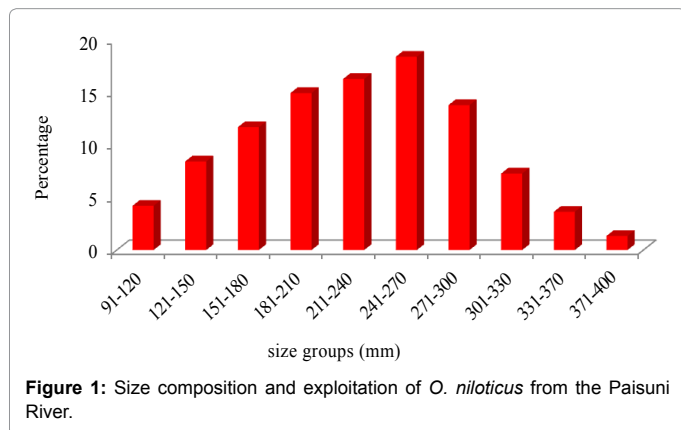
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## Results and Discussion

The flows of organic material in food webs were observed very high from the Paisuni river due to anthropogenic pollution, agricultural activities and forest behavior. The size composition (total length) of *O. niloticus* varied from 96 to 398 mm from the Paisuni river, India. *O. niloticus* is a medium size fish species. The maximum exploitation was observed in 241-270 mm with 18.39% and minimum was recorded in 371-400 mm with 1.34%. The size groups 91-120 mm, 121-150 mm, 151-180 mm, 181-210 mm, 211-240 mm and 271-300 mm exploited with 4.21%, 8.43%, 11.69%, 14.94%, 16.28% and 13.79%, respectively. The remaining stock was exploited through older fishes (Figure 1). Exploitation was significantly differentiated by seasons to seasons. The largest size of fishes (e.g., individual species) is often considered as a key measure of resource use efficiency. The largest size of *O. niloticus* is not distributed equally in the whole stretch of the Paisuni river. The large size of fishes was encountered only in the lower stretch of the Paisuni river. Although food web is assumed to supply a quantitative structure to link invaded prospective and resource use efficiency of the ecosystem [6,7,30,31]. If invaded fish species have a large body size, which is modifying the overall tropic structure of recipient communities [32,33]. Medium size fish species have more potential for resource use efficiency compared to the larger size fish species. Fish body size is given strong relationships between oxygen consumption and body size. Larger sized fishes consume more oxygen per unit time [34]. *O. niloticus* and *Cyprinus carpio* have very high potential for fish faunal homogenization of the Ganga river basin, India [35]. Both fishes have food security and livelihood in the Indian sub-continent [11,36]. The size composition of fishes in riverine ecosystem have been declined especially for commercially important fishes [37-40].

The age composition of *O. niloticus* varied from 0+ to 6+ age groups from the Paisuni river. The maximum growth increment was recorded in 1+ age group (145 mm) and minimum was recorded in 6+ age group (14 mm). The mean length was recorded 145 ± 26.5 mm, 228 ± 56 mm, 295 ± 47 mm, 350 ± 21.5 mm, 376 ± 15 and 390 ± 8 mm for 1+ to 6+ age of fishes, respectively. The 83 mm, 67 mm, 55 mm and 26 mm growth rate was reported in 2+, 3+, 4+ and 6+ years, respectively of their life cycle (Table 1). The size ranges 132-185 mm, 175-287 mm, 253-347 mm, 361-391 mm and 382-398 mm for 1+, 2+, 3+, 4+, 5+ and 6+ age groups, respectively. The size ranges of fishes indicated that those fishes which had been using resources efficiently are attaining more growth rate compared to other fishes in same age group. The size range data also indicated that the ecosystem functioning are also responsible to individual fish growth in same habitat. The food web of the Paisuni



**Figure 1:** Size composition and exploitation of *O. niloticus* from the Paisuni River.

Age	Size range (mm)	Mean length (mm)	Growth rate (mm)
0+	96-135	123	
1+	132-185	145 ± 26.5	145
2+	175-287	228 ± 56	8.3
3+	253-347	295 ± 47	67
4+	321-364	350 ± 21.5	55
5+	361-391	376 ± 15	26
6+	382-398	390 ± 8	14

**Table 1:** Age and growth of *Oreochromis niloticus* from the Paisuni river, India.

river supported to herbivorous fishes as like *O. niloticus* and *C. carpio*. These fishes dominated in the landing of the Paisuni river.

Differences in growth rate may be observed when same species inhabit different rivers of same ecoregion [41-43]. Gomez-Marquez [41] observed 1 to 4 year classes of *O. niloticus* from coastal Mississippi, USA. The growth increments of fishes are a natural process that can be driven by environmental and habitat conditions [4,6,12,44]. Grammer [45] reported slow growth rate of *O. niloticus* compared to present findings from tropical shallow lakes in Mexico. He recorded mean length as 10.61 cm in 1+, 12.43 cm in 2+ and 13.46 cm in 2.5+ age groups. Mayank [6] showed that the *O. niloticus* attained the mean length of 16.96 cm in 1+, 24.33 cm in 2+, 31.12 cm in 3+, 36.44 cm in 4+, 40.54 cm in 5+ and 43.50 cm in 6+ age group from the Yamuna river which is higher growth rate compared to the present findings. Invaded species are adapted to their own set of local ecological and environmental conditions [3,6-7]. Bwanika [46] observed age of *O. niloticus* from Lake Nabugada, Uganda ranged from 0 to 8 years. *O. niloticus* has no climatic model (e.g. norm/rule) from the Paisuni river and their potential cause negative ecological impacts. It is well stable from the Ganga river basin, India [8,47-50]. After invasion of *O. niloticus* and *C. carpio* in the Paisuni river, Tor mahsees, *T. tor* stock dramatically declined due to food and space crisis. These fishes are modifying the food web in the Paisuni river.

It may be concluded that the resource use efficiency and invasive potential of *O. niloticus* is very high from the Paisuni river. Data also indicated that the *O. niloticus* stock in near future would be increased (e.g. by size and age) from the Paisuni river. Mahseer stock from the Paisuni river in near future would totally be distorted by non-native fishes.

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