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Research Article

Suitability of Ecosystem Determination through Biology and Marketing of Exotic Fish Species, *Oreochromis Niloticus* (Linnaeus, 1757) from the Ganga River, India

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Abstract

The *Oreochromis niloticus* (Nile Tilapia) has of great socio-economic importance for the region and keeps active a population of about 700 to 900 fishers at Allahabad. The samples of *Oreochromis niloticus* were collected at random during the months of March 2008 to February 2009 from the middle stretch of the Ganga river at Allahabad, India. Preliminary information was generated on the age, growth, sex ratio and marketing of alien/exotic fish species, *Oreochromis niloticus* from the middle stretch of the Ganga river. The samples of *O. niloticus* were varying from 94 to 415 mm size groups. In case of male, the mean length was recorded 15.99 mm, 22.99 mm, 29.27 mm, 34.92 mm and 40.8 mm in 1+ to 5+ years of the life while in case of female, 15.61 mm, 22.89 mm, 28.52 mm, 34.54 mm and 37.27 mm in 1+ to 5+ years of the life. The 5+ age groups indicated that the Ganga river ecosystem is most suitable and healthy for *O. niloticus*. Sex ratio of male was higher in 0+ and 1+ age groups and female ratio was higher in 2+, 3+, 4+ and 5+ age groups. In the stock, female sex ratio was higher than male. The economic values were maximum observed for large size fishes. The market values are also varying in respect of religious and non-religious days. It may be concluded that the *O. niloticus* well stable from the Ganga river at Allahabad, India.

Keywords

Age and growth; Ganga River; Nile tilapia; *Oreochromis niloticus*

Introduction

Fishes are important organisms as they indicate the ecological and environmental processes and the producer-consumer interactions [1-3]. Fishes can be utilized for the ecological and environmental valuations at all levels of biological organization; assessment trials are existing at the levels of ecosystems, populations, individuals, organic load, metal concentrations, organs and at the cellular and molecular stages [4-9].

Oreochromis niloticus (Nile tilapia) is a non-native fish species in the India. *O. niloticus* is commonly known as Tilapia in the India. They have been transplanted in various aquatic water bodies into a huge number of tropical and sub-tropical countries in over 100 countries in the globe [10]. It is commercially exploited in the rivers Ganga with 14.56% in 2015-2016 [11] and Yamuna with 24.36% in 2011-2012 at Allahabad [12]. The tilapian species create one of the most productive and internationally traded food fish in the globe [13-15]. They are a chief source of protein in large number of the poor and developing countries. The commodity is not only the second most vital cultured fish globally (next to carp) but also labeled as the most productive aquaculture species of the 21st century [16,17].

The capability of many non-native fish species to succeed in degradation of aquatic habitats and their potential to impact on aquatic structure and there function suggest that non-native fish may represent both a symptom and cause of deterioration in river health and the integrity of indigenous communities [18,19]. Efficacious invasion of non-native fish species is broadly viewed as being more likely in anthropogenically and ecologically disturbed atmospheres [20-24]. The non-native freshwater fish species in particular have usually been renowned to thrive in the altered aquatic habitats in many zones of the world [25-28]. Non-native species are measured the second extreme reason of biological diversity loss after habitats devastation [29,30].

The growth in fishes is measured in the form of increasing in weight [31-33]. The studies on age and growth in various fish species by key scale [34-39]. However, some little and fragmentary work has been accompanied by [7,40] on the age and growth of *O. niloticus*. As far as the *O. niloticus* is concerned, there are no reports, which accounts present concept in the middle stretch of the Ganga river, India.

Material and Methods

The Ganga river is the largest of the Ganga river system covering a total distance of 2525 Km from its origin in the Himalayan state of Uttarakhand through Uttar Pradesh, Bihar and Bengal to the Bay of Bengal. The fish sample of *O. niloticus* was collected from the middle stretch of the Ganga river at Allahabad. The sample was collected during months of March 2008 to February 2009 from fish landing centre at Teliarganj (latitude 25° 30' 08" North and longitude 81° 50' 46" East). O. niloticus was collected using a variety of methods including drag netting (Mahajal, Chaundi, Darwari), cast netting, gill netting and hook and line. The most frequently encountered fishing gear was drag net (with large, medium or small meshes). The total length of each fish (from the tip to of snout to the end of caudal fin rays) was measured (mm) and recorded in fresh condition.

The key scales for age determination were collected from below the dorsal fin region (3 or 4 rows) and above the lateral line of the *O. niloticus*. The Key scales from 362 specimens of total length 9.4 to 41.4 cm were examined for the assessment of age, growth and sex ratio of *O. niloticus*. The total length of fishes was measured from the tip of the snout to the end of the largest caudal fin rays. The key scales were carefully washed in tap water until all extra matter (adhesive tissue) got completely removed and mounted intact in between two glass plates or slides. The annuli formation was determined according to the method suggested by [41] and adopted by [7,42]. Almost all the growth checks/annual rings appeared as light relatively transparent bands except the one, concentrically arranged round the whole of the anterior sculptured part of the scales.

The determination of sex was done by the microscopic vision of the gonads. After sex determination, the fish samples were segregated on the basis of their sex (male and female). The percentage of males and females and their sex ratio was computed and tested statistical significance by chi-square [43].

Results

Age and growth

Age composition of *O. niloticus* was found to vary from 0+ to 5+ age groups in case of male and female. The mean length of female fishes was low compared to male in the 1+ age group. The 5+ age group indicated that the Ganga river ecosystem is most suitable for *O. niloticus*. Data also indicated that the *O. niloticus* is well stable from the middle stretch of the Ganga river, India. These fishes mature within 6-8 months from the Ganga river at Allahabad, India.

The total lengths of male fishes ranged from 10.2 mm to 41.4 mm. In case of male, the mean length was recorded 15.99, 22.99, 29.27, 34.92 and 40.8 mm in 1+ to 5+ years of the life. The 13.6-20.2 mm, 18.2-28.8 mm, 27.2-34.6 mm 31.6-38 mm and 40.2-41.4 mm size groups fishes had 1+, 2+, 3+, 4+ and 5+ growth rings. The growth rate was maximum in 1+ year (15.99 mm). Growth rate was recorded 7.00 mm, 6.28 mm, and 5.65 mm in 2+, 3+ and 4+ years (Figure 1).

The total lengths of female fishes varied from 9.4 mm to 39.4 mm. In case of female, the mean lengths according to scale readings at ages from 1+ to 5+ years were estimated to be 15.61 mm, 22.89 mm, 28.52 mm, 34.54 mm and 37.27 mm respectively (Table 1). The maximum growth rate was attained in 1+ year (15.61 mm) and minimum in the 5+ years of the life (2.73 mm). The fish growth rate was observed to be 7.28 mm, 5.63 mm and 6.02 mm in age of 2+, 3+, and 4+, respectively figure 1.

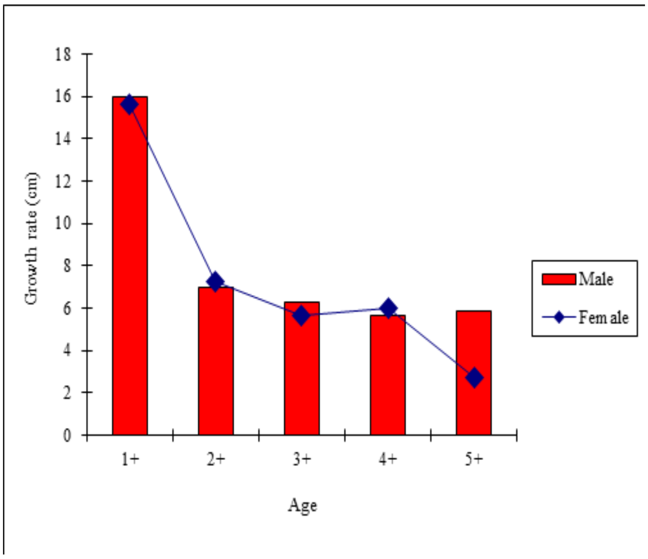

Figure 1: Growth rate of male and female *Oreochromis niloticus* from the Ganga river.

Sex ratio

Sex ratio of male was higher in 0 and 1+ age groups. The 2+, 3+ 4+ and 5+ age groups represented female ratio was higher than male (Table 2). The sex ratio was observed to be 1:0.91, 1:0.95, 1:1.06, 1:1.03, 1:1.10 and 1:1.11 in 0, 1+, 2+, 3+, 4+ and 5+ age groups respectively. Chi-square values were fluctuated from 0.02 to 0.14. In the stock, the proportion of female was higher than male. Their ratio (1:1.01) was insignificantly different from the expected ratio 1: but chi-square value 0.02 table 2. Sex ratio was very close to expected sex ratio. Sex ratio was also indicated that the Ganga river ecosystem is most suitable for *O. niloticus*.

S. No.	Age	Size range (mm)	Mean length (mm)	Growth rate (mm)
Male				
1	0+	10.2-14.3	12.01	
2	1+	13.6-20.2	15.99	15.99
3	2+	18.2-28.8	22.99	7.00
4	3+	27.2-34.6	29.27	6.28
5	4+	31.6-38.0	34.92	5.65
6	5+	40.2-41.4	40.08	5.88
Female				
1	0+	9.4-14.5	12.12	
2	1+	13.2-19.4	15.61	15.61
3	2+	19.2-28.6	22.89	7.28
4	3+	25.0-32.4	28.56	5.63
5	4+	31.8-37.2	34.54	6.02
6	5+	35.2-39.4	37.27	2.73

Table1: Age and growth of Oreochromis niloticus from the Ganga river at Allahabad

S. No.	Age	No. of Male	No. of Female	Sex ratio (M:F)	Chi-square values	Remarks
1	0+	32	29	1.0:0.91	0.14	NS
2	1+	45	43	1.0:0.95	0.04	NS
3	2+	47	50	1.0:1.06	0.10	NS
4	3+	28	29	1.0:1.03	0.02	NS
5	4+	19	21	1.0:1.10	0.10	NS
6	5+	9	10	1.0:1.11	0.06	NS
Total		180	182	1.0:1.01	0.02	NS

Table 2: Sex ratio of *Oreochromis niloticus* from the Ganga river at Allahabad.

Economic value

The economic value of present fish divided in two categories as like normal and religious days. Religious days like Tuesday, Thursday and also included religious festival such as Navaratri, Sawan mah and etc. Religious day's price of fishes low compared to normal days (Table 3). The economic values of *O. niloticus* varied from Rs. 20/Kg to Rs. 50/Kg in normal days and Rs. 10/Kg to Rs. 30/Kg in religious days table 3.

Physico-chemical characteristic of water

The water temperature was maximum in June (32.0 ˚C) and minimum in January (14.0 ˚C). Transparency was maximum in February 85. 0 cm and minimum in August 21.0 cm. The BOD was varied from 14.12 mg/l to 22.20 mg/l in March 2008 to February 2009 (Table 4). The carbon dioxide was maximum in August (3.50 mg/l) and minimum in January (1.2 mg/L).

Normal Day's					
<50 g	<100 g	<200 g	<300 g	<400 g	>400 g
Rs. 20/Kg	Rs. 25/Kg	Rs. 30/Kg	Rs. 35/Kg	Rs. 45/Kg	Rs. 50/Kg
Religious day's					
<100 g	<200 g	<300 g	<400 g	>400 g	
Rs. 10/Kg	Rs. 15/Kg	Rs. 20/Kg	Rs. 25/Kg	Rs. 30/Kg	

Table 3: Economic value of *Oreochromis niloticus* according to size at Teliarganj fish market.

S. No	**Minimum**	**Maximum**
Water Temperature ˚C	14.0	32.0
Transparency (cm)	21.0	85.0
pH	7.80	8.50
Alkalinity (mg/L)	155.2	285
Oxygen (mg/L)	3.2	6.0
Carbon dioxide (mg/L)	1.20	3.50
Ammonia (mg/L)	0.11	0.30
B.O.D. (mg/L)	14.12	22.20
Current Velocity (meter/second)	1meter/90 Second	1meter/142 Second

Table 4: Physico-Chemical features from the River Ganga at Allahabad, India.

Discussion

The growth in fishes is not recorded throughout the year. The fluctuations in the growth expressed itself on the key scales (e.g. hard body part) of the fish. The increasing length of fishes was not recorded in systematic order. The fluctuations in fish length indicate that the fish growth showed growth compensation. It is very common in almost all natural stocks of fishes (fresh water, brackish water and marine water) [44,45].

The maximum growth increment was observed in first years of life with 15.99 mm and 15.61 mm in case of male and female, respectively. Subsequently the growth was slow. The slow growth rate was observed after the second year of life may be attributed to the fishes attaining fully maturity after second year of life. It is well known that the growth potential is utilized for the gonad development [44]. Several ecological issues can interpretation for the variation in the growth increment. The quantity and quality of available food [46] and spawning cycle (e.g. frequency) [47,48] influence the growth increment of fishes. [49] Mehanna (2004) observed that the mean length of *Tilapia zilli* from Wadi El-Raiyan lake 14.74, 22.18, 26.69 and 29.38 cm in 1 to 4 age groups. [7] Mayank and Dwivedi (2015) reported 6+ age groups in the Yamuna River at Allahabad [50]. Oliva-Paterna *et al*. (2002) found *Cobitis paludica* grows fast during the year before first breeding. Similarly, [51] recorded faster growth increments during the first year in other small or large fish species. Growths of fishes are altering by fishing activities and resource availability in the ecosystem [52,53].

The size composition and exploitation structure were indicated that the *O. niloticus* a powerful invader in the Yamuna river. Female was more exploited than male in the Yamuna river at Allahabad [54]. Sex ratio of fished were varied from season to season but expected ratio (1:1) most suitable for proper recruitment [55,56]. In general, Tilapia are well identified for their plasticity in growth increment, breeding biology, age and size-at- first maturity that not only make them an brilliant aquaculture taxa but also tolerate them the ability to invade (e.g. introduced) and become established in non-native environments [57,58]. Multiple breeding potential of *O. niloticus* are additional eminence for powerful invader in any freshwater ecosystem. *O. niloticus* breeding biology is categorized by short generation time, multiple clutches and extended breeding period/seasons [59-61]. In the present study female population was greater than male. [62] Komolafe and Arawomo (2007) reported the sex of *O. niloticus* 1:0.8 (M:F) in Opa reservoir, Nigeria. [63] Dwivedi and Jha (2013) reported that the female population of *O. niloticus* was greater than male in the Ganga river. Sex ratio of fishes varied from season to season [7].

O. niloticus is a tropical fish species that desires to live in shallow water. The maximum and minimum suitable water temperature for *O. niloticus* is 12-42 ˚C, while the ideal temperature between 25 to 36 ˚C. Tilapian species can survive at very low concentration of DO (dissolved oxygen) as they can also consume atmospheric oxygen [64-66] and plasticity shows in respect of metal concentration [67-69]. Present findings indicated that the no effect of physico-chemical characteristic of the water in the biology of *O. niloticus* because healthy growth increment and 5+ age groups was observed.

In present investigation, *O. niloticus* was low price fishes. For any commodity, product marketing is very important, and the fish-marketing concept has change with the increasing fish production. Marketing channels play a vital role in meeting the demand for fish [70]. In general, the nutritive value of all species of fish may be almost same but there are different types of market demand and prices for various species [71]. The price of fish also affects the landing of the fishes through fishing preferences and they change the composition of species in the river [72]. A species is harvested on a local scale and market is established, providing profit. Others then become interested in exploiting the species to get a share of the profit. As the stocks start to decline and become difficult to harvest, raising prices for the consumer and competition among the harvesters [73-75].

It may be concluded that the resource availability (e.g. food) and breeding biology most effective parameters for the stability of exotic species in any ecosystem. Breeding and feeding of the fishes are providing very suitable chance for stabilization of the stock in the ecosystem [76-79].

It may be concluded that the *O. niloticus* well stable (5+ age group) from the Ganga river at Allahabad, India. The growth increment also indicated that the environmental condition of the Ganga river supports to *O. niloticus*.

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