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Scale Based Age and Growth Analysis of Exotic Fish Tilapia (*Oreochromis mossambicus* P 1852) in Vallabhsagar Reservoir, Gujarat, India

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ABSTRACT

The current study was conducted during post monsoon season (November, 2021–April, 2022) and 505 tilapia scales were randomly collected from the commercial fish collection centers i.e. Naranpur, Nesu Vadpada and Rumkitalav of Vallabhsagar reservoir, Gujarat, India. Fish scales described the age and growth of tropical conditions that provided detailed facts about their life history, ecology and habitat of fish which help to manage the water body for optimum fish production. The result showed that age of tilapia ranged from 1+ to 5+ year with total length 15.000–33.700±23.598 cm and weight 77.000–662.000±309.951 g. The calculated length (cm) of the back was 8.80, 14.758, 21.612, 26.170 and 28.846 cm while body weight (g) 17.690, 76.171, 223.369, 386.865 and 506.744 g were noted for 5 age classes respectively. The average specific size (5.77) and the index of population weight growth intensity (157.00) were observed whereas specific rate of linear growth (C_l) and specific rate of weight increase (C_w) were decreasing with increase in age. The growth constant average ($C_{lt(Ave)}$) shows two growth phases, i.e. 0.67 and 0.22. The findings of current study help to conclude that the aquatic environment of Vallabhsagar reservoir was suitable to harbour these fishes and was conducive for satisfactory growth and wellbeing of tilapia. Results of the study provided baseline information which would be helpful for the scientific management of Tilapia fisheries in the Vallabhsagar Reservoir in Gujarat.

KEYWORDS: Tilapia, ecology, growth, tropical, Vallabhsagar reservoir, weight

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1. INTRODUCTION

Tilapia (*O. mossambicus* P. 1852) is member of the Cichlidae family and natively accommodated in the aquatic resources of Africa and Madagascar, which have been introduced in natural waters of tropical and sub-tropical countries over the world (Trewavas, 1983). Tilapia is a highly successful culture species in many countries mainly due to rapid growth rate, highly efficient reproductive strategy, wide hydrological tolerance and habitat preferences and wide range of feed components. Therefore, this species contributes important share in the world fish production especially in Asia about 72%, Africa 19% and America 9% of the total world tilapia production (Sugunan, 1995, Anonymous, 2017). Tilapia was introduced in Indian waters for aquaculture, mosquito control and aquatic weed control during 1952 (Sugunan, 1994) and now this fish existed in almost every water body because of strong parental care, sturdy nature and omnivorous feeding habit (Biju Kumar, 2000, Ujjania et al., 2008).

In tropical environmental condition hard body parts such as otolith, operculum bone, dorsal spine and scales have been extensively used to determine the age and growth of fish. In these, use of scale is simple and inexpensive technique and is popular as it is easy to collect, process and analysis of the fish scales samples without sacrificing the fish specimens. The important biological informations elucidated by scale based age and growth analysis are the helpful to determine the population composition, age, maturity, life span, mortality, growth, production etc. of fish. The ageing of fishes from annual increments on scales were estimated earlier by Dua and Kumar (2006) in channa fish, Kanwal and Pathani (2011) in gara fish and Ujjania et al. (2013) in Indian major carps. Whereas, similar studies were conducted for *O. mossambicus* by Tachihara and Obaxa (2003) in Genka River (Okinawa Island), Ujjania et al. (2004) and Ujjania et al. (2013) in Jaisamand Lake (India). Ibrahim et al. (2008), Mahmoud and Mazrouh (2008) and Kariman and Alaa (2009) were also conducted the similar studied the in other cichlids.

The study of length-weight relationship of tilapia is having vital importance to fisheries biologists as it serves three purposes. First, it establishes the mathematical relationship between the two variables, length and weight so that the unknown variable can be readily calculated from the known variables in practical fisheries problem. Secondly, the relative condition can be estimated to assess the general wellbeing of the animals. The actual relationship between length and weight may part from the cubic value 3 and this may be due to environmental condition in which the animal lives and also due to the physiological condition of the animal. The facts on the age and growth of this important fish species is an essential prerequisite for the more detailed study on biological and to management aspects of the fisheries of tilapia. Although tilapia fish is an important source of food in surrounding area of Vallabhsagar reservoir and till the date not many studies on fish biology in relation to age and growth of this have been carried out. The objective of present study was to acquire the data on age and growth rate of this exotic Cichlidae tilapia (*O. mossambicus*) by means of scale readings in Vallabhsagar reservoir which is large water body of Gujarat (India).

2. MATERIALS AND METHODS

The present study was conducted during post monsoon season (November, 2021–April, 2022) and 505 tilapia scales were randomly collected from the commercial fish collection centers i.e. Naranpur, Nesu Vadpada and Rumkitalav of Vallabhsagar reservoir, Gujarat, India.

2.1. Study area

Vallabhsagar reservoir is popularly known as Ukai dam and one of the largest reservoirs of Gujarat state which is situated on 73° 32' 25" to 78° 36' 30" East longitudes and 20° 5' 0" to 22° 52' 30" North latitudes geographical location. It was constructed across the Tapi river in 1972 (Figure 1) for multipurpose including agriculture, hydroelectricity, industry, domestic use etc. and secondary it is used for fish farming also. The morphometric features of water body include height (80.772 m), length (4972 m), water storage capacity (7414.29 mm^3), surface area (612 km^2) and catchment area 62,255 (km^2).

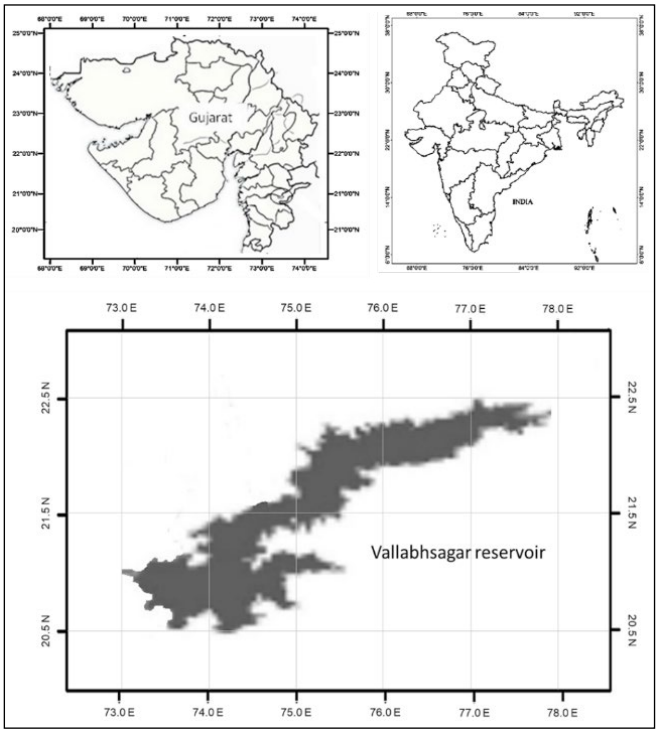

Figure 1: Map of study area

2.2. Sample collection

The scale samples (505) were collected from selected fish specimens during the post-monsoon season (November 2021 to April 2022) from the important commercial fish collection centers i.e. Naranpur, Nesu Vadpada and Rumkitalav of Vallabhsagar reservoir. For the proposed study, about 5–6 scale samples from above the lateral line and below dorsal fish of each fish were collected in paper envelop with keynote informations such as total length (cm), standard length (cm), weight (g), date of scale collection, name of fish species, name of lending center, name of sample collector etc. The total length (length from snout to caudal end) and standard length (length from snout to caudal peduncle) of fish was measured with help of measuring tape and body weight (WT) was measured by single pan balance.

2.3. Sample analysis

These collected scales were treated in 1% KOH solution and wash with tape water by rubbing with fingertip to remove extraneous matter including mucus and dirt particles. These clean and transparent scales were used to measure the scale radius (S, diagonal length from focus point of scale margin) and annulus radius (S_1, S_2, S_3 S_4…. S_n, diagonal length from focus point to annuli of the scale) using the 4P scale reader to follow the method of Ujjania et al. (2014). These scales were analyzed at the Research Laboratory, Department of Aquatic Biology (VNSGU, Surat).

2.4. Calculation of growth parameters

The back calculation for the length, weight, growth and growth parameters such as growth characteristics, specific linear growth, growth constant, specific rate of weight increase, index of species average size and index of population weight growth intensity were estimated on the basis of following equations

Back calculation length and weight of fish:

$Ln=a+(Sn/S)\times(L-a)$

$W + aL^b$

$\text{Log } W=\text{Log } a+b \text{ Log } L$ ……(1)

(Bagenal and Tesch, 1978, Biswas, 1993, LeCren, 1951)

Specific rate of linear growth:

$Cl=(Ln-Ln-1/Ln-1)\times100$ ……(2)

(Chugunova, 1963)

Growth characteristic:

$Cth=(\text{Log } Ln-\text{Log } Ln-1/0.4343)\times Ln-1$ ……..(3)

(Chugunova, 1963)

Growth constant:

$Clt= (\text{Log } Ln-\text{Log } Ln-1/0.4343)\times(t2+t1)/2$ ……(4)

(Chugunova, 1963)

Specific rate of weight increase:

$Cw=(Wn-Wn-1/Wn-1)\times100$ ……..(5)

(Chugunova, 1963)

Index of species average size:

$\phi h=(\Sigma h=1/nj+a)$, $h=nj+a$ ……(6)

(Balon, 1971)

Index of population weight growth intensity:

$\phi h=(\Sigma Cw=1/nj+a)$, $Cw=nj+a$ ……(7)

(Balon, 1971)

Where,

L_n=Length of fish when the annulus 'n' was formed

L=Length of fish at time scale sampling

S_n=Radius of annulus 'n'

S=Total scale radius

a=Correction factor

L_n, L_{n-1}=Total length of fish at ultimate and penultimate age

W_n, W_{n-1}=Weight of fish at ultimate and penultimate age

j=Juveniles

h=Absolute increase in length

t_1, t_2=Time intervals between ultimate and penultimate age

3. RESULTS AND DISCUSSION

3.1. Observed length and weight

The total length and weight were minimum (15.00 cm and 77.00 g), maximum (33.70 cm and 662.00 g) and mean (23.589 cm and 309.951 g) at the time of capture of studied fish tilapia in Vallabhsagar reservoir (Table 1). The similar range of length and weight of tilapia were also reported by Ujjania et al. (2013) in Jaisamand Lake of Rajasthan.

3.2. Back calculated length and weight

The age and growth status in terms of length and weight are explained on the basis of back calculated length and weight with the help of cycloid type scale of exotic fish tilapia which was characterized by distinct marks on these scales. The total length and scale analysis of tilapia revealed that fish population of Vallabhsagar reservoir belong to 5+ age groups (Figure 2) which containing by +1 (60, 11.9%), +2 (132, 26.2%), +3 (125, 24.8%), +4 (145, 28.7%) and +5 (43, 8.4%) numbers and percentage respectively of population with 8.80 cm, 14.758 cm, 21.612 cm, 26.170 cm and 28.846 cm of length, respectively (Table 2). Similarly, body weight for observed 5 age classes were noted 17.690 g, 76.171 g, 223.369 g, 386.865 g and 506.744 g respectively (Table 1 and 2). Although data shows that length and weight was having normal increasing trends with age but sudden increment in weight at-or-after age of 2nd year of fish were

Figure 2: Typical scales image of tilapia with mark of annulus

also observed (Figure 3). The results on length and weight were interpreted that exotic fish tilapia was surviving in better manner in the aquatic environment of Vallabhsagar that could be justified by satisfactory growth and wellbeing of fish. Similarly, Ujjania and Sharma (1999), Ujjania et al. (2004) and Ujjania et al. (2013) observed satisfactory growth of tilapia in Jaisamand Lake Rajasthan.

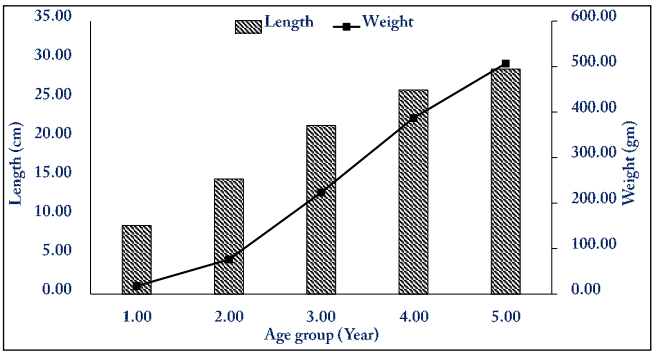

Figure 3: Back calculated mean length and mean weight of studied fish tilapia

3.3. Growth parameters

Scales based growth parameters were shows that average specific size (5.77) and the Index of population weight growth intensity (157.00) were observed (Table 2). Ujjania et al. (2004 and 2013) was observed for tilapia in Jaisamand and Ana Sagar Lake respectively. The length increment (C_l) was 67.70 in +1 and +2 year class, 46.45 in +2 and +3 year class, 21.09 in +3 and +4 year class, and 10.22 in +4 and +5 year class whereas, specific rate of weight increase (C_w) was observed 330.58 between I–II year classes,193.25 between II–III between III–IV year classes and 30.99 between IV–V year classes. These results are in evidences with Ibrahim et al. (2008), Mahmoud and Mazrouh (2008) and Ujjania et

Table 1: Annual growth in terms of length (cm) and weight (g) of fish

Age group	N		Observed length and weight		Back calculated length and weight of fish			
			L	W	L_1	W_1	L_2	W_2
1+	60	Min	15.000	77.000	9.321	20.154		
		Max	18.000	122.000	11.407	35.738		
		Mean	16.808	98.500	10.118	25.547		
2+	132	Min	18.000	133.000	5.991	10.689	5.753	29.717
		Max	23.000	281.000	10.588	17.973	28.931	129.739
		Mean	19.719	172.769	8.608	14.917	16.683	79.100
3+	125	Min	20.800	190.000	7.442	13.250	19.830	10.643
		Max	26.200	415.000	9.958	17.347	24.990	24.309
		Mean	22.910	277.960	8.491	14.530	21.509	15.676
4+	145	Min	25.000	381.000	7.418	12.592	18.617	22.450
		Max	31.500	660.000	10.804	18.293	26.269	31.672
		Mean	28.479	487.069	8.872	15.012	21.970	26.509
5+	43	Min	27.000	266.000	6.877	12.327	18.456	22.012
		Max	33.700	662.000	9.660	16.723	24.269	28.984
		Mean	29.700	496.000	8.334	14.287	21.006	25.381
Total	505	Min	15.000	77.000	5.991	5.753	10.689	29.717
		Max	33.700	662.000	11.407	35.738	18.293	136.407
		Mean	23.598	309.951	8.800	17.690	14.758	76.171

Table 1: Continue...

Age group	N		Back calculated length and weight of fish					
			L_3	W_3	L_4	W_4	L_5	W_5
1+	60	Min						
		Max						
		Mean						
2+	132	Min						
		Max						
		Mean						
3+	125	Min	54.656	171.472				
		Max	117.331	330.435				
		Mean	71.789	217.619				
4+	145	Min	10.548	47.301	143.368	243.812		
		Max	30.634	136.407	380.657	647.009		
		Mean	18.050	80.195	235.740	400.959		
5+	43	Min	25.671	8.507	44.530	139.886	230.558	356.585
		Max	33.228	22.308	105.766	304.078	503.144	741.313
		Mean	29.185	15.147	69.335	206.868	353.690	524.780
Total	505	Min	18.456	139.886	22.012	230.558	25.671	356.585
		Max	26.269	380.657	31.672	647.009	33.028	728.698
		Mean	21.612	223.369	26.170	386.865	28.846	506.744

Length: (L in cm); Weight: (W in g); N: Number of observations; Min.: Minimum; Max.: Maximum

Table 2: Growth parameters and growth rate of fish

Growth parameters		Age or year class of fish				
		1	2	3	4	5
Back calculated length (cm)	L	8.800	14.758	21.612	26.170	28.846
Annual length increment (cm)	H	8.80	5.96	6.85	4.56	2.68
Index of species average size	⌀H			5.77		
Specific rate of linear growth	Cl	67.70	46.45	21.09	10.22	
Growth characteristics	Cth	4.55	5.63	4.14	2.55	
Growth constant	Clt	0.78	0.57	0.29	0.15	
Growth constant average	Clt(av)	0.67		0.22		
Calculated weight in (g)	W	17.690	76.171	223.369	386.865	506.744
Annual weight increment (g)	w	17.69	58.48	147.20	163.50	119.88
Specific rate of weight increase	C_w	330.58	193.25	73.19	30.99	
Index of weight growth intensity	⌀ C_w			157.00		

al. (2013). The growth constant (C_{lt}) and average growth constant ($C_{lt(Ave)}$) was high during the initial stage compare to later stage of life that indicated the active growth period was at initial life i.e. first year. In present study two growth periods (0.67 and 0.22) were observed, first was 0.67 during the year class I and II due to fast growth of fish and second was (0.22) due to slow growth of fish at year class III onwards (Table 2). The findings of current investigation conformed to earlier studies of Ujjania and Sharma (1999), Ujjania et al. (2004) and Ujjania et al. (2013) on tilapia in different water bodies. According the present study, occurrence of 5+ year old tilapia was observed which is clearly indicated that tilapia probably got entry in Vallabhsagar reservoir in the year 2016–17.

4. CONCLUSION

Results revealed that 5+ year class of exotic fish showed well existence and good dissemination which needed regular monitoring of the growth parameters to find the information on fish population structure and dynamics. This would help in observing status and changing trends of fish population in this water body. Although studied fish makes very less contribution in fish production but prolific breeding of this fish could have alarming impact on indigenous fishes in the reservoir.

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