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Preliminary observations on age and growth of exotic fish Tilapia (*Oreochromis mossambicus* P.) from Ana Sagar Lake, Ajmer (India)

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Abstract
In present paper the scale based detail description on age and growth was expounded that provide detailed information on the life history, ecology of fish and habitat which are important to manage the water body for fish production. This study was conducted during October 2017 to January 2018 and examined the 172 scales of tilapia from commercial fish catch of Ana Sagar Lake, Ajmer (India). The findings of this study reveal that the age of tilapia population varied between 1+ to 4+ year classes with total length (15.00-24.00 cm) and weight (60.00-250.00 gm). During this study different growth parameters were analyzed in that the specific rate of linear growth (C_l) and specific rate of weight increase (C_w) showed decreasing trends with increasing of age. The growth constant average ($C_{lt(Ave)}$) depicted two growth phases (0.48 and 0.25). On the basis of results of this study it can be inferred that aquatic environment of Ana Sagar Lake, Ajmer is conducive and favorable for this fish which offers the opportunities for satisfactory growth and wellbeing of tilapia. This field data of Tilapia may serve as tool for regulating tilapia population.

Keywords: Ana Sagar Lake, age, growth and tilapia

Introduction
Exotic fish tilapia (*O.mossambicus* P.) is well known to survive in numerous aquatic environmental conditions (Trewavas, 1983) [21] and it was overcrowded in water bodies due to strong parental care and omnivorous feeding habit. In Jaisamand lake this fish was initially observed in the fish catch during 1990s (Anon, 1995) [1] and population was continuously increased in the total catch (Jain and Gupta, 1994 and Ujjania, 1997) [9, 23] which remains a cause of worry for the fishery biologists (Anon, 1995; Biju Kumar, 2000 Ujjania *et al*., 2008 and Ujjania *et al*., 2015) [1, 4, 25].
The age and growth study elucidated important informations to analyze and determine the population composition, age, maturity, life span, mortality, growth, production etc. of fish. Under tropical environmental conditions hard body parts such as scales have been extensively used for estimation of age and growth parameters. Ageing of fishes from annual increments of scales were estimated earlier by many scientists (Dua and Kumar, 2006; Kanwal and Pathani, 2011; Ujjania *et al*., 2013 and Sudarshan and Kulkarni, 2013) [7, 12, 27, 20]. This simple and inexpensive methods is popular as it is easiest method to collect and process the fish scales without sacrificing the fish specimens. Some studies are also available on age and growth of *O. mossambicus* with the use of body scales (Ujjania, 1997; Ujjania and Sharma, 1999; Ujjania *et al*., 2004; Ujjania *et al*., 2013 and Lad *et al*., 2014) [23, 22, 24, 27, 15]. Ibrahim *et al.*, (2008) [8], Mahmoud and Mazrouh (2008) [17] and Kariman and Alaa (2009) [13] were also conducted the similar studied the in other cichlids.
Scale based growth studies for the first time on Tilapia of Ana Sagar Lake, Ajmer were attempted in present study. Under this study parameters such as growth characteristics (Cth), specific linear growth (Cl), growth constant (Clt), specific rate of weight increase (Cw), index of species average size (Øh) and index of population weight growth intensity (ØCw) have been estimated. These parameters usually provide information on age and growth of fish investigated. Such information will be help to conserve indigenous fisheries resources of the water body for evolving appropriate scientific management policy.

Materials and methods
Study area
Ana Sagar Lake is located on 26°27'-26°29' N latitude and 74°36'- 74°37' E longitude in the center of the Ajmer city, Rajasthan (Fig. 1). The catchment area of the lake is widely spread from Nagpahar hills and Taragarh hills which includes 5 (4 full and 1 partial) villages and some part of the Ajmer city. Capacity of lake is about 2052 million liters and average depth is 5 meters (Ranga 1995) [18].

Sample collection
Different sized fish specimens of tilapia (N = 172) were randomly collected from the commercial fish landing center during October 2017 to January 2018. The total length (TL) of fish was measured with help of measuring tape in centimeter (cm) and body weight (WT) was noted by single pan balance nearest to 1.0 gm whereas scales form each specimen were collected in paper envelop with keynote data (total length,

body weight, date of collection etc.) for further studies.

Sample analysis

Scales were dipped in 1 % KOH solution for 5 minutes followed by washing 2-3 times with tap water. To remove the mucus and other attached material scales were gently rubbed by fingertips. The scales measurements like radius of scale (S) and radius of every annuli (S_1, S_2, S_3 S_4…….S_n) were measured from the focal point. The scale readings were taken using the 4P scale reader at Department of Aquatic Biology, VNSGU, Surat.

Growth parameters analysis

The back-calculated length-weight and growth parameters such as growth characteristics (C_{th}), specific linear growth (C_l), growth constant (C_{lt}), specific rate of weight increase (C_w), index of species average size (Øh) and index of population weight growth intensity ($ØC_w$) were estimated on the basis of following equations:

1. Length calculation (Bagenal and Tesch, 1978; Biswas, 1993 and LeCren, 1951) [2, 5, 16]

$$Ln = a + \frac{Sn}{S} \times (L-a)$$

$$W = aL^b$$

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

2. Specific rate of linear growth (Chugunova, 1963) [6]

$$Cl = \frac{Ln - Ln\text{-}1}{Ln\text{-}1} \times 100$$

3. Growth characteristic (Chugunova, 1963) [6]

$$Cth = \frac{\text{Log } Ln - \text{Log } Ln\text{-}1}{0.4343} \times Ln\text{-}1$$

4. Growth constant (Chugunova, 1963) [6]

$$Clt = \frac{\text{Log } Ln - \text{Log } Ln\text{-}1}{0.4343} \times \frac{t2 + t1}{2}$$

5. Specific rate of weight increase (Chugunova, 1963) [6]

$$Cw = \frac{Wn - Wn\text{-}1}{Wn\text{-}1} \times 100$$

6. Index of species average size (Balon, 1971) [3]

$$Øh = \frac{\sum h = 1}{nj + a}, \quad h = nj + a$$

7. Index of population weight growth intensity (Balon, 1971) [3]

$$ØCw = \frac{\sum Cw = 1}{nj + a}, \quad Cw = nj + a$$

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 and t_1, t_2 = time intervals between ultimate and penultimate age.

Statistical Analysis

Statistical analysis was done by Window Excel 10 software.

Results and Discussion

In present study, the back calculated age and growth status in terms of length and weight are explained on the basis of cycloid scales of tilapia which were characterized by distinct growth markings. The detailed description of the results is described as bellow:

Back Calculated Length and Weight

The total length of tilapia fish population in Ana Sagar lake ranged between 15.00 -24.00 (18.38) cm at the time of capture and scale analysis revealed that fish specimens belong to 4 age classes e.g. +1 (21), +2 (68), +3 (65) and +4 (18) with 11.07, 15.24, 17.90 and 21.25 cm of length, respectively. Similarly, body weight of fish ranged between 60.00 – 250 (130.54) gm at the time of capture and the body weight for these 4 age classes were observed 41.53, 84.65, 121.52 and 177.44 gm respectively (Table 1). These finding were interpreted that studied fish tilapia is enjoying the favorable aquatic environmental condition in Ana Sagar lake which is the sign of satisfactory growth and wellbeing of fish could be justified. Similarly, Kelly (1957) [14], Raskamp (1960) [19], Ujjania (1997) [23], Ujjania and Sharma (1999) [22], Ujjania *et al*., (2004) [24] and Ujjania *et al*. (2013) [27] observed satisfactory growth in different water bodies.

Growth parameters

On the basis of scales analysis growth parameters were calculated and average specific size (5.31) and the Index of population weight growth intensity (64.47) were observed (Table 2) which is fairly comparable with the findings of Johal and Tandon (1987) [11] for Indian major carps from northern India and Ujjania *et al*., (2004 & 2013) [24, 27] for tilapia in Jaisamand Lake. Studied fish attained maximum length increment (C_l) in the + 1 year class (37.65) as compared to the +2 year class (17.46) whereas, specific rate of weight increase (C_w) were observed 103.84 between I - II and 43.56 during II - III year classes. These results are in agreement with Ibrahim *et al*. (2008) [8], Mahmoud and Mazrouh (2008) [17] and Ujjania *et al*. (2013) [27]. The growth constant (C_{lt}) and average growth constant ($C_{lt(Ave)}$) was high during the initial year of life which indicate the active growth period was at first year. Based on average growth constant ($C_{lt(Av)}$) growth periods have been demarcated in fishes (Johal and Tandon, 1987) [11]. Two growth periods were also observed in the present study wherein the first was (0.48) during the year class I due to fast growth of fish and second was (0.25), it was very low due to slow growth of fish at year class II onwards (Table 2). The findings of current investigation conformed to earlier studies of Johal and Tandon (1985) [10] on rohu and Ujjania (1997)

[23], Ujjania and Sharma (1999) [22], Ujjania *et al*., (2004) [24] and Ujjania *et al*. (2013) [27] on tilapia in different water bodies. As shown in Table 2 and Figure 2 it is further evident that in the catch the highest length and weight of tilapia occurred in 4+ age group. The occurrence of 4+ year of the studied fish also indicates that in Ana Sagar lake Tilapia probably got entry some time in the year 2013.

Conclusion

On the basis of findings of this study it is concluded that aquatic environment of Ana Sagar Lake, Ajmer is favorable for wellbeing and satisfactory growth of the tilapia. These findings also shows that need to regularly monitor the growth parameters for the information on fish population structure and dynamics which would help in observing status and changing trends of tilapia population in this water body as the prolific breeding of this fish is likely to make adverse impact on indigenous carps. It clearly indicated that the population of studies fish is likely to grow fast which only can be controlled by the application of suitable remedial measures.

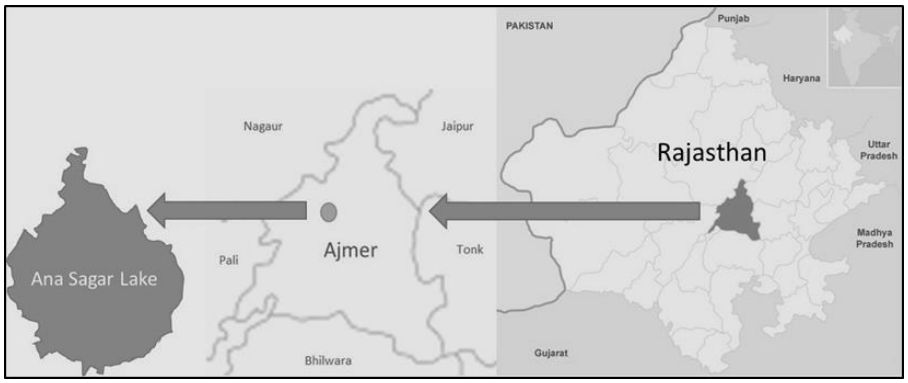

Fig 1: Map of study area

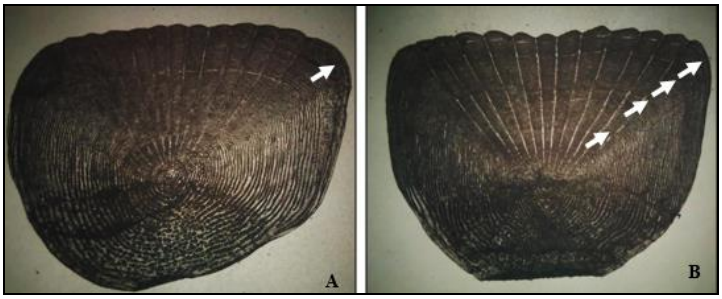

Fig 2: Typical scales image of tilapia (A is 1+ year class and B is 4+ year class)

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

Age group	N		Observed length & weight		Back calculated length and weight of fish							
			L	W	L_1	W_1	L_2	W_2	L_3	W_3	L_4	W_4
1+	21	Min	15.00	80.00	10.86	39.05						
		Max	16.50	90.00	12.10	49.81						
		Mean	15.58	85.08	11.53	44.76						
2+	68	Min	15.00	60.00	8.34	21.55	13.18	60.31				
		Max	19.00	135.00	14.10	70.25	18.25	125.52				
		Mean	17.11	110.58	10.93	40.42	15.62	89.41				
3+	65	Min	17.00	125.00	8.80	24.33	12.64	54.90	15.68	89.16		
		Max	24.00	220.00	14.76	83.07	19.33	142.75	23.45	220.55		
		Mean	19.61	146.81	11.23	43.49	14.79	79.21	17.86	120.97		
4+	18	Min	22.0	200.0	9.59	29.52	13.30	61.62	16.68	102.46	19.11	139.10
		Max	23.5	250.0	11.55	44.88	16.51	100.18	19.78	150.33	22.35	197.95
		Mean	22.7	225.0	10.59	37.12	15.31	85.14	18.23	125.85	21.25	177.44
Total	172	Min	15.00	60.00	8.34	21.55	12.64	54.90	15.68	89.16	19.11	139.10
		Max	24.00	250.00	14.76	77.83	19.33	142.75	23.45	220.55	22.35	197.95
		Mean	18.38	130.54	11.07	41.53	15.24	84.65	17.90	121.52	21.25	177.44

Length - (L in cm), Weight - (W in gm), N – number of observations, Min. – Minimum and Max. - Maximum

Table 2: Growth parameters and growth rate of fish

Growth parameters		Age or year class of fish			
		1	2	3	4
Back calculated length (cm)	L	11.07	15.24	17.90	21.25
Annual length increment (cm)	H	11.07	4.17	2.66	3.35
Index of species average size	∅H	5.31			
Specific rate of linear growth	C_l	37.65	17.46	18.72	
Growth characteristics	C_{th}	3.54	2.45	3.07	
Growth constant	C_{lt}	0.48	0.24	0.26	
Growth constant average	$C_{lt(av)}$	0.48	0.25		
Calculated weight in (gm)	W	41.53	84.65	121.52	177.44
Annual weight increment (gm)	w	41.53	43.12	36.87	55.92
Specific rate of weight increase	C_w	103.84	43.56	46.02	
Index of weight growth intensity	∅C_w	64.47			

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