ASSESSMENT OF AGE AND GROWTH OF EXOTIC FISH TILAPIA
(OREOCROMIS MOSSAMBICUS P.) IN LAKE JAI SAMAND, INDIA

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ABSTRACT
This study based on the examination of scales of 90 tilapia (O.mossambicus P.) individuals from commercial catch from Jaisamand Lake, Udaipur (India). The growth parameters including growth characteristics (Cm), specific linear growth (Ct), growth constant (Ci), specific rate of weight increase (Cw), index of species average size (Oth) and index of population weight growth intensity (OCw) were estimated. In studied population age composition varied between 1+ to 4+ year class and 3+ age group was dominated. The mean total length (30.450 cm) and weight (534.950 gm) were observed. The specific rate of linear growth (Ct) and specific rate of weight increase (Cw) in this study observed decreasing trends with increasing of age. The growth constant (Cm) the growth constant (Ci) and average growth constant (Cm(Ave)) during the initial year of life is high indicate that the fish had active growth period during first year. In view of these findings it can be inferred that environment of Lake Jaisalmand is conducive and offers opportunities for high growth as well as wellbeing for tilapia. This study on age and growth may serve as a good tool for regulating tilapia population in this water body in future.

Key Words: Tilapia, Age and Growth, Jaisamand Lake, Conservation

INTRODUCTION
The Jaisamand Lake is one of the largest man made freshwater body situated on 24° 14' N latitude and 73° 57' E longitude at an altitude of 587 m (MSL) with a maximum depth of 32 m and mean depth of 15 m. It was constructed in 1729 AD about 56 km away in South East of Udaipur city in the southern Rajasthan. The age old existence of the lake and specific morphometric features provide opportunities for the high biological production. Kohli et al., (1998) estimated the productivity, nutrients status and biodiversity of microfauna and flora of various water bodies including Lake Jaisamand of southern Rajasthan. Durve (1976) reported for high fish production comparable to the most productive standing water bodies.

The exotic fish Tilapia (Oreochromis mossambicus P.) was noticed in 1991 in fish catch (Anon, 1995) probably it was accidental entry with seed of Indian major carp. The prolific breeder, strong parental care and omnivorous feeding habit are the main reasons for overcrowding of tilapia in the water body and it survives longer due to hardiness and adaptability. The potential for overcrowding leads to recruitment alteration and competition for food (Courtenary and Stauffer, 1984; Fuller et al., 1999; Ujjania et al., 2004). The fish production and community structure of local fish fauna were affected by high density and abundance of tilapia.

The fish production data fluctuation due to contribution of tilapia suggest simultaneous impact on the total production of the Indian major carps and cat fishes as evident from the data (Singh, 1994; Ujjania, 1997; Durga and Srivastava 2008; Ujjania et al., 2004). Similarly, Courtenary and Hensley (1979) reported decrease in population size of established exotic fishes due to overcrowding of spotted tilapia in canal. Age and growth data of fish is in congestion with length and weight measurements which can give the information on stock composition, age and maturity, life span, mortality, growth, production etc. These studies have earlier been done by Chacko and Krishnamoorthy (1951), Gupta and Jhingran (1973) and Bhatnagar (1979). Ujjania (1997) worked on age and growth of O. mossambicus from Lake
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Jaisamand, Udaipur (India) by examining scales. Similar studies were also done by Ibrahim et al., (2008), Mahmoud and Mazrouh (2008) and Kariman and Alaa (2009) in cichlids. The objective of present study was to provide update information on the growth and effects of tilapia on domestic fauna in Jaisamand Lake

MATERIALS AND METHODS

Collection of Sample

For the present investigation fish production data of Jaisamand Lake were collected from Department of Fishery (Government of Rajasthan), Udaipur and key scales from 90 fish specimens were randomly collected from 'Namla' fish landing center of Jaisamand Lake (Figure 1) during the fishing year 2012-13. These key scales were preserved in small paper envelopes bearing with fish details like total length (cm), weight (g), date of collection etc.

Scale Analysis

The scales were dipped in 1 % KOH solution for 5-10 minute and gentle wash with tap water to remove extraneous matter and mucous and these clean scales were examined under 4P scale reader.

Back Calculation of Length

The length of the fish at the time of formation of annuli could be estimated using following relationship given by Bagenal and Tesch (1978):

\[ S_n = a + \frac{x (L - a)}{S} \]

Where: \( L_n \) is length of fish when the annulus ‘n’ was formed, \( L \) is length of fish when scale sample was obtained, \( S_n \) is radius of annulus ‘n’, \( S \) is total scale radius and \( a \) is correction factor i.e. intercepting point between TL and Scale Radius (Figure 2).

Growth Parameters Based on Scale Analysis

The 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 (\( \bar{O}_h \)) and index of population weight growth intensity (\( \bar{O}_C_w \)) were also estimated to follow the below mentioned equations:

\[ W = aL^b \]  
(Biswas, 1993)

\[ \frac{\log W - \log L}{L_n - L_{n-1}} = b \log L_n - \log L_{n-1} \]  
(LeCren, 1951)

\[ C_l = \frac{\log W_n - \log W_{n-1}}{L_n - L_{n-1}} \times 100 \]  
(Chugunova, 1963)

\[ C_w = \frac{W_n - W_{n-1}}{W_{n-1}} \times 100 \]  
(Chugunova, 1963)

\[ C_{th} = \frac{\log L_n - \log L_{n-1}}{0.4343} \times L_{n-1} \]  
(Chugunova, 1963)

\[ C_{lt} = \frac{\log L_n - \log L_{n-1}}{0.4343} \times \frac{t_2 + t_1}{2} \]  
(Chugunova, 1963)
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\[
\sum h = 1 \\
\bar{O}h = \frac{h = n_j + a}{n_j + a} \quad \text{(Balon, 1971)}
\]

\[
\sum C_w = 1 \\
\bar{O}C_w = \frac{C_w = n_j + a}{n_j + a} \quad \text{(Balon, 1971)}
\]

Where: \( L_n, L_{n-1} \) is total length of fish at ultimate and penultimate age, \( W_n, W_{n-1} \) is weight of fish at ultimate and penultimate age, \( j \) is juveniles, ‘a’ is adult, \( h \) is absolute increase in length and \( t_1, t_2 \) is time intervals between ultimate and penultimate age.

Statistical Analysis

Statistical analysis of observed data was done by PAST software.

RESULTS AND DISCUSSION

In present study structural details of cycloid scales of tilapia were characterized by distinct markings which was represent the growth periods. It was depicted in figure 1 and table 1 that specimen were belongs to age class +1 (9), +2 (15), +3 (54) and +4 (12) with 17.833 cm / 99.167 g, 27.500 cm / 390.200 g, 32.083 cm / 576.778 g and 36.256 cm / 854.500 g length / weight at the time of capture respectively (Table 1).

The growth parameters on the basis of scales calculated which revealed notable increase 11,619, 20,259, 28,070 and 33,301 cm in length and 30,209, 151,871, 395,825 and 653,531 g in weight for I, II, III and IV year classes respectively. These observations interpreted that tilapia enjoy favorable environmental conditions of the aquatic environment of Lake Jaisamand and observed high growth and well being in tilapia could be justified. Kelly (1957) observed 84 gm growth in 18 weeks whereas Raskamp (1960) considers growth 85-120 gm in 8 months in Tilapia to be a sign of fast growth.

Under Indian conditions Chacko and Krishnamoorthy (1954) reported a growth of 22 cm in 8 months for \( T. mossambica \) and considered this as fast growth. During the study period (1996-1997) the highest size/weight of tilapia recorded by Ujjania (1997) from Lake Jaisamand and it was 43.5 cm/1620 gm, respectively. In the present study it was also confirmed that Tilapia attained average length of 24.3 cm and weight of 330 gm in one year that is comparable to the observations of Chacko and Krishnamoorthy (1954).

From the growth performance of Tilapia as noted from back calculated growth parameters (Table 2) it is evident that the average specific size (\( \bar{O}h \)) was 12.95 and the Index of population weight growth intensity (\( \bar{O}C_w \)) was 82.43. These results are fairly comparable to that of Johal and Tandon (1987) reported in Indian major carps. These results also indicate that the fish attained maximum length increment in the +1 year class \( (C_1 22.95) \) as compared to the +2 year class \( (C_1 19.94) \). In corroborates with weight gain wherein, the fish also attained maximum weight \( (C_w 89.34) \) between I and II as compared to \( (C_w 72.52) \) during II and III year classes. The growth constant \( (C_{nh}) \) and average growth constant \( (C_{ln(Ave)}) \) during the initial year of life is high (Table 2) indicate that the fish had active growth period during first year.

Based on average growth constant, growth periods have been demarcated in fishes (Johal and Tandon, 1987). Balon (1968) suggested that average value of growth characteristics \( (C_{nh}) \) is useful parameter for demarcating the growth periods. In the present study, the value of growth characteristics \( (C_{nh}) \) showed notable increment in the catch size. These growth trends clearly indicate that there was a well-marked irregularity in \( (C_{ln}, C_w) \) growth during different years. This conforms to the earlier studies on \( Labeo rohita \) (Johal and Tandon, 1985).
**Figure 1:** Map of study area

**Figure 2:** Graph between Total length (cm) and scale radius (cm)

\[ L = -0.228 + 0.447S \]
In the present study, all the studied cichlid species attained their highest growth rates in length during the first year of life, after which a gradual decrease was noticed with further increasing in age (Table 2). These results are in accordance with those of Ibrahim et al., (2008) and Mahmoud and Mazrouh (2008). In view of above findings, it can be inferred that environment of Lake Jaisalmand is conducive for tilapia which offers opportunities for high growth and well being of this fish. As the above stated growth increase seems to be high under Indian conditions especially in wild waters, these data may serve as a good tool for regulating Tilapia population in this water body in future. The above findings also indicate that there is need to monitor age and growth parameters regularly together with studies on fish population structure and dynamics in a more comprehensive manner.
### Table 1: Annual Growth of fish in terms of Length (cm) and weight (gm)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>No of specimens</th>
<th>TL (cm) of fish at capture time</th>
<th>WT (gm) of fish at capture time</th>
<th>Average (cm)</th>
<th>Back calculated length</th>
<th>Average (gm)</th>
<th>Back calculated weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L₁</td>
<td>L₂</td>
<td>L₃</td>
<td>L₄</td>
<td>W₁</td>
<td>W₂</td>
</tr>
<tr>
<td>1+</td>
<td>9</td>
<td>Min 17.500</td>
<td>98.500</td>
<td>8.182</td>
<td>9.979</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max 18.000</td>
<td>100.000</td>
<td>14.516</td>
<td>54.810</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean 17.833</td>
<td>99.167</td>
<td>10.645</td>
<td>26.364</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Min 21.500</td>
<td>169.000</td>
<td>9.612</td>
<td>16.103</td>
<td>107.524</td>
<td></td>
</tr>
<tr>
<td>2+</td>
<td>15</td>
<td>Max 31.000</td>
<td>531.000</td>
<td>12.000</td>
<td>31.135</td>
<td>186.560</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean 27.500</td>
<td>390.200</td>
<td>11.235</td>
<td>25.999</td>
<td>165.328</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Min 29.000</td>
<td>452.500</td>
<td>10.394</td>
<td>20.315</td>
<td>76.638</td>
<td>255.074</td>
</tr>
<tr>
<td>3+</td>
<td>54</td>
<td>Max 35.500</td>
<td>744.000</td>
<td>14.351</td>
<td>52.979</td>
<td>253.790</td>
<td>527.939</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean 32.083</td>
<td>576.778</td>
<td>11.820</td>
<td>30.682</td>
<td>152.330</td>
<td>395.591</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Min 33.000</td>
<td>655.500</td>
<td>10.076</td>
<td>18.527</td>
<td>85.775</td>
<td>290.356</td>
</tr>
<tr>
<td>4+</td>
<td>12</td>
<td>Max 38.000</td>
<td>932.500</td>
<td>13.818</td>
<td>32.244</td>
<td>85.442</td>
<td>612.126</td>
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<tr>
<td></td>
<td></td>
<td>Mean 36.250</td>
<td>854.500</td>
<td>12.460</td>
<td>32.443</td>
<td>146.996</td>
<td>439.243</td>
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<td></td>
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<td>Min 17.500</td>
<td>98.500</td>
<td>8.182</td>
<td>9.979</td>
<td>76.638</td>
<td>255.074</td>
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<tr>
<td>Total</td>
<td>90</td>
<td>Max 38.000</td>
<td>932.500</td>
<td>14.516</td>
<td>54.810</td>
<td>253.790</td>
<td>612.126</td>
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<tr>
<td></td>
<td></td>
<td>Mean 30.450</td>
<td>534.950</td>
<td>11.691</td>
<td>30.209</td>
<td>153.946</td>
<td>403.528</td>
</tr>
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</table>
Table 2: Growth parameters and growth rate of fish

<table>
<thead>
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<th>Parameters</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>11.691</td>
<td>20.259</td>
<td>28.070</td>
<td>33.301</td>
</tr>
<tr>
<td>H</td>
<td>11.691</td>
<td>8.569</td>
<td>7.811</td>
<td>5.231</td>
</tr>
<tr>
<td>ØH</td>
<td>8.325</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C_l</td>
<td>73.293</td>
<td>38.554</td>
<td>18.636</td>
<td></td>
</tr>
<tr>
<td>C_th</td>
<td>6.428</td>
<td>6.606</td>
<td>4.797</td>
<td></td>
</tr>
<tr>
<td>C_l(t)</td>
<td>0.825</td>
<td>0.489</td>
<td>0.256</td>
<td></td>
</tr>
<tr>
<td>C_l(tav)</td>
<td>0.825</td>
<td>0.373</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>30.209</td>
<td>151.871</td>
<td>395.825</td>
<td>653.531</td>
</tr>
<tr>
<td>w</td>
<td>30.191</td>
<td>121.662</td>
<td>243.954</td>
<td>257.706</td>
</tr>
<tr>
<td>C_w</td>
<td>402.736</td>
<td>160.633</td>
<td>65.106</td>
<td></td>
</tr>
<tr>
<td>ØC_w</td>
<td>209.492</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Parameters:
- L: Back calculated length (cm).
- h: Annual length increment (cm).
- Øh: Index of species average size
- C_l: Specific rate of linear growth
- C_th: Growth characteristics
- C_l(t): Growth constant
- C_l(tav): Growth constant average
- W: Calculated weight (gm).
- w: Annual weight increment (gm).
- C_w: Specific rate of weight increase.
- ØC_w: Index of weight growth intensity

This would help in assessing status and changing trends of Tilapia population in Lake Jaisamand. Such efforts would also help in assessing any probable adverse impact of Tilapia on indigenous carp fishery of this lake. The results of this research clearly point out that Tilapia population is likely to grow further in this lake unless suitable remedial measures at war footings are adopted.

REFERENCES
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