BASE LINE DATA ON AGE AND GROWTH OF TILAPIA *(Oreochromis mossambicus* P.) FROM LAKE JAISAMAND, INDIA

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Abstract

Age and growth of Tilapia *(Oreochromis mossambicus* P.) from Lake Jaisamand (24° 14' N latitude and 73° 57' E longitude), Udaipur (India) was studied using key scales. Annual rings or annulii were observed to estimate selected growth parameters. Maximum three annual rings were found and used to assess growth data in the samples representing 0 to +3 year classes. The data on growth characteristics revealed that the performance of Tilapia in Jaisamand has clearly indicated opportunities for further proliferation of this fish in lake. These trends may adversely influence age-old carp fishery of Jaisamand.

Introduction

The Lake Jaisamand is situated 56 km Southeast to Udaipur, Rajasthan, which is the largest state of India. This lake has been reported to have fish production comparable to the most productive standing waters (Durve, 1976). The age old existence (about 270 years) of this man-made lake and specific morphometric features provide opportunities for high biological production in this water body that has been supporting fisheries of valuable carps and catfishes till recently. Due to indiscriminate fishing in 1960s, the carp fishery had a set back in the subsequent period. However, from 1980 Rajasthan Tribal Area Development Cooperatives Federation Ltd. (RTADCF) has started stocking of major carp seed in Jaisamand.

In 1990s occurrence of exotic fish Tilapia *(0. mossambicus.* P.) was noticed in the fish catch (Anon, 1995) probably on account of accidental entry with Indian major carp seed. The reported occurrence of exotic fish Tilapia in the fish catch has been cause of worry for the fishery biologists (Jain and Gupta, 1994; Anon, 1995) as the production data for the past few years show an alarming and continuous increase in the total number of Tilapia caught (Singh, 1994). In view of the likely adverse impact of Tilapia on the indigenous carp fishery, the age and growth of this exotic Cichlid were studied.

In the present study attempts has been made to investigate the key scale of Tilapia for finding relevant information such as size, scale rings and relative values of growth 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) were estimated. Based on these observations age and growth parameters of Tilapia from Jaisamand Lake have been calculated.

Age data of a fish is in congestion with length and weight measurements. Such studies can give information on stock composition, age and maturity, life span, mortality, growth, production etc. Manon *et al.* (1985) worked on age and growth of *Labeo fimbriatus* from Mettur reservoir in Tamil Nadu (India) by examining scales. Similar studies have earlier been done by Chacko and Krishnamoorthy (1951), Gupta and Jhingran (1973) and Bhatnagar (1979). Such studies were also performed by Johal and Tandon (1985) on *Labeo rohita.* Natrajan and Jhingran (1963), Kamal (1969), Hanumantha Rao (1974), Pathani (1981) restricted their studies mainly for back calculation of length. Singh (1994) also described the age and growth characteristics of *Labeo rohita* by the use of key scales.

Khan and Jhingran (1975) have made the use of age and size studies in calculating the first maturity in Indian major carps. Johal and Tandon (1983) while studying the age and growth of *C. catla* and *C. mrigala* from Lake Sukhna, Chandigarh by the use of scales found that the growth rate of these fishes was lowest as compared to the populations of other localities. On the basis of scale studies they interpreted that *C. catla* up to 3+ years of life increases rapidly in length but at 4+ years and onwards there is an appreciable increase in weight as compared to length. They also found the condition factor increases with increase in length and weight of fish. The slow growth of fish in Sukhna Lake was assigned to oligotrophic nutrient status of lake.

Prakash and Gupta (1986) have studied the growth rate of *C. catla, L. rohita* and *C. mrigala* of Govindgarh Lake by means of scale. They have studied the influence of age and seasons on growth rate. The growth rate in all the species is rapid for the first five years of life after which growth increment is very little. The growth rates were found to be high during August-October and February-April and low during May-June.

Materials and methods

Description of study area

The Lake Jaisamand has been known for supporting a lucrative carp fishery in the past. It is situated at 24° 14' N latitude and 73° 57' E longitude at an altitude of 587 m (MSL) in the southern Rajasthan. This lake occupies an area of 7160 ha at FRL with a maximum depth of 32 m and mean depth of 15 m. The lake is about 270 years old and was primarily made as an irrigation reservoir. Several seasonal streams and nine rivers are draining a catchment area 1127 sq km of this lake.

Collection of Samples

During this study 150 samples of key scales from 50 fishes were collected randomly from the 'Namla' commercial landing center of the Lake Jaisamand, during 1996-1997. For this purpose, key scales of sampled fishes were collected and secured in small paper envelopes bearing details of fish such as length, weight, date of collection etc. Before observing the scale, extraneous matter and mucous were removed by a gentle wash in tap

water. For observing annuli in the scales a Kinderman automatic slide projector was used. The cleaned scales were first placed between two glass slides and tied with the help of a rubber band. The true image of scale was projected with the help of slide projector on the screen. The image so produced was then photographed (Plate 1).

To calculating correction factor 'a', graph between total length and scale radius was plotted. The radius of annuli was also measured. The length of the fish at the time of formation of annuli could be estimated through Bagenal and Tesch (1978):

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

where:

Ln = Length of fish when the annulus 'n' was formed
L = Length of fish when scale sample was obtained
Sn = Radius of annulus 'n'
S = Total scale radius
A =Correction factor (intersecting point between T L and Scale Radius)

Relative values of growth parameters based on scale studies

The relative values of growth parameters were calculated using the following formulae have been used (Balon, 1971 and Johal and Tandon, 1983):

$$W = aL^{b}$$

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

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

$$Clt = \frac{\text{Log } Ln - \text{Log } Ln\text{-}1}{0.4343} \times \frac{t_2 + t_1}{2}$$

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

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

$$Øh = \frac{\sum h = 1}{nj + a}, \qquad h = nj + a \text{ (Balon, 1971)}$$

$$\text{ØCw} = \frac{\sum \text{Cw} = 1}{\text{nj} + \text{a}}, \quad \text{Cw} = \text{nj} + \text{a (Balon, 1971)}$$

Where:

Ln, Ln-1	= total length of fish at ultimate and penultimate ages.
Wn, Wn-1	= Weight of fish at ultimate and penultimate ages.
j	= juveniles
a	= adult
h	= absolute increase in length
t_1, t_2	= time intervals between ultimate and penultimate ages

Results and discussion

In the present study on Tilapia scales, structural details of typical cycloid type of scales were characterised by distinct markings that represent the growth periods. It may be seen that most of the specimens belong to the age class +2 (22) followed by age class + 1 (18) and +3 (10) (Plate 1 and Table 1). These results indicate average lengths of 28.2, 35.0 and 43.0 cm in Tilapia at the time of capture for +1, +2 and +3 year classes respectively. The back calculated lengths of Tilapia are also presented in Table 1. The mean values of back length were found to be 26.4, 32.3 and 38.8 cm at I, II and III year classes, respectively.

In this study an attempt was also made to establish relationship between the scale readings and selected morphometric parameters of Tilapia (Table 2). As such these results indicated highly significant correlation coefficient 'r' values. Here, the exponent 'n' varied between 0.266 - 0.278 for fish weight and scale dimensions. Whereas, exponent 'n' varied between 0.864 - 0.902 for fish length and scale readings. The most significant correlation (r = 0.907) was found in the case of fish weight and width of scale.

The growth characteristics calculated (Table 3) with the use of scales revealed notable increase in length (L) and weight (W) which have been 26.44, 32.99, 38.85 cm and 330, 625, 1057 gm for I, II and III year classes respectively. These observations further clarify that Tilapia enjoy favorable environmental conditions of lake. For this reason very high growth and well being observed in Tilapia could be justified. Kelly (1957) considers growth of 84 gm 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 recorded from Lake Jaisamand was 43.5 cm / 1620 gm, respectively for Tilapia. 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 (*op. cit.*).

From the growth performance of Tilapia as noted from backcalculated growth parameters (Table 3) it is evident that the average specific size (Øh) was 12.95 and the Index of population weight growth intensity (ØCw) was 82.43. These results are fairly comparable

Table 1. The values of back calculated lengths (cm) of Tilapia from Jaisamand Lake.

S.N.	Age group	Sample No.	Length of fish (cm)	L_1	L_2	L_3
1	+1	18	25.0-30.0 (28.2)	20.4-26.5 (24.3)	-	-
2	+2	22	30.5-41.5 (35.0)	20.7-35.1 (26.9)	24.5-38.5 (31.7)	-
3	+3	10	42.0-43.5 (43.0)	29.5-32.8 (30.7)	33.6-35.9 (34.7)	37.9-40.4 (38.8)
4	1 to 3	50	25.0-43.5 (33.5)	20.4-35.2 (26.4)	24.5-38.5 (32.3)	37.9-40.4 (38.8)

Values in parenthesis indicate average values.

Table 2. Regression equation for selected morphometric parameters on scale reading.

Morphometric parameters on scale	'r'
Total Length v/s Scale Height	
Log L = -1.324 + 0.864 Log SH,	0.936
Total Length v/s Scale Radius	
Log L = -1.600 + 0.902 Log SR,	0.891
Total Length v/s Scale Width	
Log L = -1.254 + 0.878 Log SW,	0.936
Fish Weight v/s Scale Height	
Log W = -0.763 + 0.266 Log SH,	0.872
Fish Weight v/s Scale Radius	
Log W = -1.014 + 0.278 Log SR,	0.866
Fish Weight v/s Scale Width	
Log W = -0.685 + 0.270 Log SW,	0.907

to that of Johal and Tandon *(op. cit.)* reported in Indian major carps. These results also indicate that the fish attained maximum length increment in the + 1 year class (CI 22.95) as compared to the +2 year class (CI 19.94). In corroborates with weight gain wherein, the fish also attained maximum weight (Cw 89.34) between I and II as compared to (Cw 72.52) during II and III year classes. The growth constant (Clt) and average growth constant (Clt $_{(Av)}$) during the initial year of life is high (Table 3) 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, *op. cit.)*. Balon (1968) suggested that average value of growth characteristics (Cth) is useful parameter for demarcating the growth periods. In the present study, the value of growth characteristics (Cth) showed notable increment in the catch size. These growth trends clearly indicate that there was a well-marked irregularity in (Cth, Cw) growth during different years. This conforms to the earlier studies on *Labeo rohita* (Johal and Tandon, *op. cit.)*.

In view of above findings, it can be inferred that Tilapia enjoys a favorable environment of Lake Jaisamand, 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 base line 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.

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.

Table 3. Backcalculated growth data of Tilapia during 1996-97 from Lake Jaisamand.

Parameters	Year class		
	1	2	3
L	26.44	32.39	38.85
H	26.44	5.95	6.49
Øh	**12.95**		
Cl	**22.95**	**19.94**	
Cth	5.359	5.859	
Clt	0.304	0.273	
$Clt_{(Av)}$	0.304	0.273	
W	330.00	625.00	1097.00
w	330.00	295	472.00
Cw	89.34	72.52	
ØCw	**82.43**		

Note:

L	Back calculated length (cm)
H	Annual increment (cm)
Øh	Index of species average size
Cl	Specific rate of linear growth
Cth	Growth characteristics
Clt	Growth constant
$Clt_{(Av)}$	Average growth constant
W	Calculated weight of fish (gm)
w	Annual increase in weight (gm)
Cw	specific rate of weight increase
Øcw	Index of population weight growth intensity

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References

Anon. 1995. "Afriki Machhali Phailaw Se Jaisamand Jheel Ki Desi Machhalion Par Sankat", *Rajasthan Patrika*. 11.12.1995.

Bagenal, T.B. and F.W. Tesch. 1978. Age and Growth, p. 101-136. *In*: T.B. Baganal (ed.). *Methods for Assessment of Fish Production in Freshwater*. 3rd Edition. IBP Handbook No. 3. Blackwell Scientific Pub.,Ltd. Oxford.

Balon, E.K. 1968. The periodicity and relative indices of the growth of fishes (with notes on their terminology). *In*: *International Conference of Aging and Growth of Fishes*, Smolenice, Czechoslovakia. pp. 115-143.

Balon, E.K. 1971. A short methodological out line for production survey of freshwater fish population (with examples from Lake Kariba). UNDP/FAO, Central Fisheries Research Institute, Zambia, pp. 1-18.

Bhatnagar, G.K. 1979. "Studies on the age and growth of *Labeo fimbriatus* (B.) from river Narmada". *J. Inland Fish Soc. India*, 11(2): 96-108.

Chacko, P.I. and B. Krishnamoorthy. 1951. "Age and growth of the carp *Labeo fimbriatus* (B.) as revealed by scales". *IPFC Technical paper* (Summary).

Chacko, P.I. and B. Krishnamoorthy. 1954. "Observation on *Tilapia mossambica* P. in Madras". *Bombay Natl. Hist. Soc*. 52(2) B: 349-353.

Durve, V.S. 1976. "The fisheries of Lake Jaisamand, Rajasthan". *J. Inland Fish Soc. India*, 8: 19-23.

Gupta, S.D. and A.G. Jhingran. 1973. "Aging *Labeo calbasu* (Ham) through its scale". *J. Inland Fish Soc. India*, 5: 126-128.

Hanumantha Rao, L. 1974. "Studies on the biology of *Cirrhinus mrigala* (Ham.) of the river Godavari". *Indian J. Fish*., 21 (2): 303-322.

Jain, A.K. and A.K. Gupta. 1994. "Occurrence of Tilapia in Jaisamand Lake. A threat to indigenous fishery resources of Rajasthan". *Fishing chimes*, 1994: 15.

Johal, M. S. and Tandon, K. K. 1983. "Age, growth and length-weight relationship of *Catla catla* and *Cirrhinus mrigala* (Pisces) from Sukhna Lake Chandigarh (India)". *Vestn. Cesk. Spol. Zool.* 47: 87-98.

Johal, M.S. and K.K. Tandon. 1985. "Use of growth parameters in *Labeo rohita* (Pisces: Cyprinidae)". *Vest. Cs. Spolec. Zool*., 49: 101-107.

Kamal, M.Y. 1969. "Studies on the Age and growth of *Cirrhinus mrigala* (Ham) from commercial catches at Allahabad". *Proc. Natl. Acad. Sci. India*. 35 B (1): 72-92.

Kelly, H.D. 1957. "Preliminary studies on *Tilapia mossambica* P. relative to experimental pond culture". *Proc. 10th Ann. Conf. S.E. Assoc*. Games and Fish Comm.

Khan, H. A. and Jhingran, V. G. 1975. "Synopsis of biological data on the Rohu, *Labeo rohita* (Hamilton, 1822)". *FAO Fish. Synopsis.*

Manon, M.D., B.K. Murthy and P.I. Chack. 1985. "Age and growth of fresh water fishes of Madras state, *Labeo jimbriatus* B". *Year book of Fisheries* Department, Madras.

Natrajan, AV. and V.G. Jhingran. 1963. "On the biology of *Catla catla* (Ham) from the river Yamuna". *Proc. Natl. Inst. Sci., India*, 29: (3): 326-355.

Pathani, S.S. 1981. "Age and growth of Mahseer *Tor Putitora* (Ham) as determined by the scale and operculum". *Matsya*, 7: 41-46.

Prakash, Shree and Gupta, R. A. 1986. "Studies on the comparative growth rates of three major carps of the Govindgarh Lake". *Ind. J. Fish.* 33(1): 45-53.

Raskamp, G.S., Jr. 1960. "*Tilapia mossambica* P.: Preliminary finding in Netherlands, New Guinea", *I.P.F.C. Occasional paper*, 66/1.

Singh, S. 1994. "Some aspects of fishery and biology of *Labeo rohita* (Ham) from Lake Jaisamand, Rajasthan". M. Sc. (Ag.) *Thesis. Raj. Agril. Univ. Bikaner*

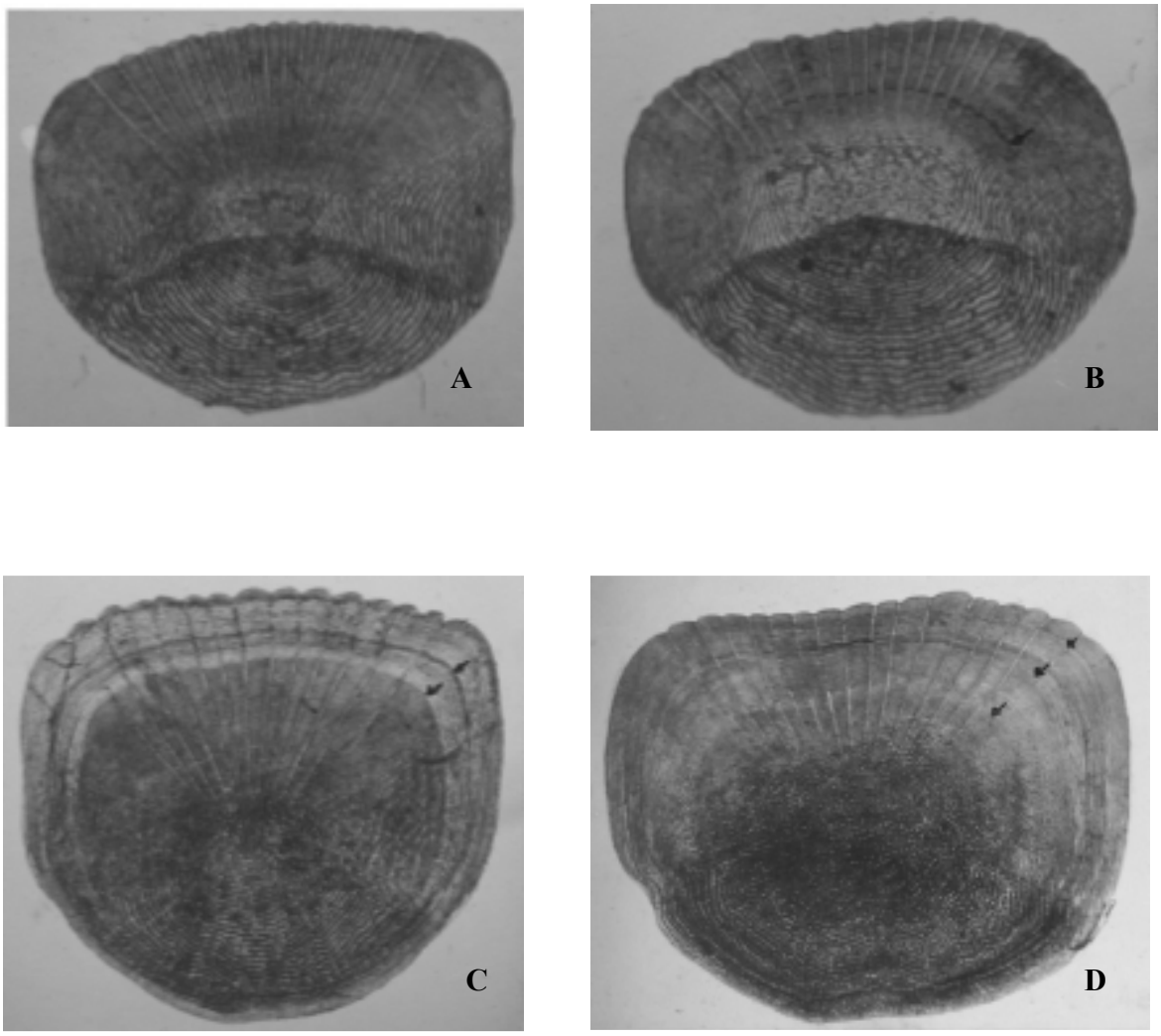

Plate 1. Imagery of Tilapia's scale

A. Scale of '0' year class
B. Scale of '+1' year class
C. Scale of '+2' year class
D. Scale of '+3' year class