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VALIDATION OF THE SCALE METHOD FOR AGE AND GROWTH STUDIES OF *LABEO ROHITA*

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Labeo rohita age and growth data were obtained from the Chashma Barrage, District Mianwali during the period November, 1974 - October, 1976. In all, 265 *Labeo rohita* were collected over this period. Scales were measured for 255 fish. Identity of scales through out life, time of annulus formation, length frequency distribution and year class strength, proved the validity of annulus as the year mark. There was a good agreement between calculated and observed fork-length at the end of each year of life.

INTRODUCTION

Attempts have been made to study the age and growth of *Labeo rohita* (Mitra, 1942; Hora, 1944; Ganapati & Chacko, 1950; Das, 1959 and 1960) but none has critically examined the scale method as applied to this species. Evidences presented here show that the annuli on the scales of *Labeo rohita* are valid year marks and the measurements of scale can provide reliable estimates of fork length at the end of each year of life.

MATERIALS AND METHODS

In total 265 specimens of *Labeo rohita* were collected from November, 1974 to October, 1976 from Chashma Barrage, District Mianwali. The samples included all sizes of fish. A complete discussion of measuring fish is given by Ricker and Merriman (1945) and Scattergood (1950). The fork length in the study was measured using a board with head stop and a graduated rule. The fork length was measured in millimeters and the weights of the fish in grams. Before taking the scale sample excess mucus and dirt were wiped off the sides of the fish with the blunt end of a knife and it was latter found that scales collected in this way were much easier to clean. Scales were removed from the left side of the body from an area above the lateral line and below the dorsal fin. Three or four apparently complete scales were

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dipped in a dilute solution of ammonia. The scales which were softened and straightened were later on cleaned with a very soft brush. Following this, one or two scales from each envelope were mounted dry between two glass slides held together by thin layer of freshly prepared Araldite placed at both the ends. The slides were numbered and placed in respective envelopes. The scale of *Labeo rohita* has been described by Haque (1955).

Scales were read thrice by a binocular microscope to resolve any difference between various readings. The annuli, circuli and radii were quite conspicuous under the binocular and scales were easy to read. The number of annuli on the scales was the age of the fish in years which was expressed by Roman numeral. A fish in the second year of life was regarded as belonging to the age group I+; a fish in the third year of life was included in age group II+; and so on. Fish hatched in the same calendar year was considered as the member of same year class. The 1970 age group III+, 1971 age group IV+ and 1972 age group V+, all belong to the 1966 year class.

Only 255 scales were photographed and the enlarged photographs of scales were measured in millimeters. The ruler was placed in such a position that it bisected the photograph and measurements were taken from focus to the each annulus and also from focus to the anterior margin of the scale.

RESULTS

Use of scales for age determination and back calculations is based on the following assumptions (Van Oosten, 1929) :

i) Scales maintain their identity and number.

ii) Annuli are recognizable marks formed on the scales at the same time each year.

iii) Increase in scale radius is proportional to increase in fish length.

The evidence presented below show that the annuli on *Labeo rohita* scales are indicators of age and that scale measurements can provide reliable estimates of fork length at the end of each year of life.

A. *Identity of Scales Throughout Life.* The number of scales along the lateral line was used as a measure of a number of scales covering the body of 25 specimens of *Labeo rohita* of various sizes. This collection included fish of all age and length groups. The average scale count on lateral line ranged from 41-42 and was not related to length group or age group of the

fish showing that the number of scales on the lateral line of *Labeo rohita* remain constant throughout life. Scales which were dislodged at any time were replaced by regenerated scales which will be easily recognized by the granulated scar tissue at the focus. Creaser (1926) and Van Oosten (1929) pointed out that such scales were unsuitable for age determination. All other scales maintain their identity during the life of fish and were suitable for age and growth study.

B. *Time of Annulus Formation.* Of all the scales in the collection only 13 had marginal annuli which were collected in March, 1976, which show that the annulus formation started either late in February or early March. Various causal factors which are considered important in the formation of annulus of tropical and subtropical fishes have been given by Menon (1953).

C. *Validity of the Annulus as Year Marks.* Evidence that the annuli are valid year marks is derived from observations described below :

1. *Length Frequency Distribution*: There was a corelation between the number of annuli on the scales and length of the fish, as length increased so did the number of annuli. With increase in length, age increased but the length range of any age group was quite variable (Table 1). The data of Table 1 were important in showing

Table 1. *Length frequencies by age groups of* 256 *Labeo rohita, collected from Chashma Barrage*, 1974–76.

Fork length	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
201 - 250	—	1	2	3	—	—	—	—	—	—	6
251 - 300	—	4	8	4	—	—	—	—	—	—	16
301 - 350	1	9	7	2	—	—	—	—	—	—	19
351 - 400	—	5	12	3	—	—	—	—	—	—	20
401 - 450	—	—	10	12	2	3	1	1	—	—	29
451 - 500	—	3	11	31	13	9	4	—	—	1	72
501 - 550	—	3	13	17	10	11	3	2	1	—	60
551 - 600	—	—	3	9	6	4	3	2	2	—	29
601 - 650	—	—	—	1	3	2	3	1	3	1	14
Total	1	25	66	82	34	29	14	6	6	2	265

the approximate total range of length and the degree of overlap of length-frequency of all age groups. The amount of overlap between the consecutive age groups was so great that in most instances the fish of given length could belong to any of several age groups. Anyhow, the modal lengths of all the age groups stand out distinctly.

2. *Year Class Strength.* The success of hatching in various years can be estimated from the number of youngones. The hatches of some years may be so successful that the particular year class may dominate in the fishery for one or several years. Other hatches may be represented by very small numbers indicating a poor year for hatching. Table II shows that the 1971 year class was the strongest and maintained its higher number in the subsequent age groups. These patterns of succession indicate that *Labeo rohita* can be accurately assigned to age groups by counting annuli on their scales.

D. *Accuracy of Ageing and Back Calculations.* The annuli can safely be called as yearmarks if observed length at various ages and back calculated length at the same age agree. The back calculated growth histories of ten age groups of *Labeo rohita* based on the sample of 258 fish are shown in Table III. In deriving this table, fish of the same age group were grouped together irrespective of the year of capture. Observed and calculated lengths did not differ much. The difference was greater in the younger age group than the older. The reason for this difference was that the fish were placed in age groups because of the number of annuli on their scales, but in fact many of them show some post annulus growth at the edge of the scale. Moreover, the size of the fish when scale first appeared was not taken into account. Table III shows that the calculated lengths of all the age groups were less than the observed lengths.

DISCUSSION

To study the age and growth of fish, it is imperative to validate the methods to be used for age determination. Historically, the scale method for age determination was evolved out of the pioneer works of Thompson (1904). Lea (1910) derived first formula for back calculation and this was improved by Mottram (1916). Methods of estimating body length of fish have been given in detail by Lagler (1952).

Table II. *Length at the end of each year of life for Labeo rohita, by year class from Chashma Barrage, 1974-76.*

Year	Mean fork length at the end of each year of life (mm). I	II	III	IV	V	VI	VII	VIII	IX	X
1964	106.93 (2)	152.12 (2)	189.30 (2)	238.15 (2)	297.46 (2)	348.48 (2)	01.95 (2)	443.75 (2)	473.85 (2)	508.28 (2)
1965	117.11 (5)	185.75 (5)	249.77 (5)	297.33 (5)	336.37 (5)	407.33 (5)	453.78 (5)	500.91 (5)	547.91 (5)	—
1966	73.16 (4)	137.98 (4)	191.35 (4)	255.46 (4)	325.41 (4)	386.20 (4)	435.49 (4)	484.92 (4)	—	—
1967	105.21 (11)	174.85 (11)	244.05 (11)	309.22 (11)	375.75 (11)	444.02 (11)	491.46 (11)	—	—	—
1968	118.31 (23)	200.93 (23)	269.06 (23)	336.90 (23)	402.26 (23)	462.56 (23)	549.14 (2)	—	—	—
1969	129.61 (16)	220.55 (16)	306.95 (16)	386.12 (16)	457.82 (16)	527.68 (5)	—	—	—	—
1970	137.74 (43)	252.70 (43)	349.39 (43)	429.92 (43)	485.89 (16)	506.05 (2)	—	—	—	—
1971	136.95 (50)	262.26 (50)	381.93 (50)	439.46 (28)	447.46 (7)	—	—	—	—	—
1972	125.09 (44)	218.10 (44)	312.73 (44)	382.48 (33)	—	—	—	—	—	—
1973	140.68 (39)	251.14 (39)	320.71 (30)	—	—	—	—	—	—	—
1974	126.72 (17)	251.26 (17)	—	—	—	—	—	—	—	—
1975	194.33 (1)	—	—	—	—	—	—	—	—	—
Mean length	125.98	209.78	281.52	341.67	391.05	440.33	466.36	476.52	510.45	508.28
Annual growth increment	125.98	83.80	71.74	60.15	49.38	49.29	26.03	10.16	33.93	
No. of fish	255	254	228	165	84	84	24	11	7	

Table III. *Mean calculated fork length in millimeters at annulus formation of Labeo rohita, collected from Chashma Barrage, 1974-76.*

Age groups	No. of fish	Mean fork length at capture (mm)	Mean calculated length at each year of life									
			I	II	III	IV	V	VI	VII	VIII	IX	X
II	25	368.32	145.32	276.73	—	—	—	—	—	—	—	—
III	64	414.27	137.83	257.29	356.93	—	—	—	—	—	—	—
IV	82	470.73	129.88	237.46	340.93	423.15	—	—	—	—	—	—
V	32	513.78	124.69	223.27	314.11	394.76	465.95	—	—	—	—	—
VI	27	515.41	122.27	206.77	280.00	344.81	413.02	473.18	—	—	—	—
VII	14	535.86	105.61	181.30	255.64	325.82	392.31	456.37	505.04	—	—	—
VIII	6	547.70	79.61	147.42	201.56	262.88	330.15	395.43	455.12	510.66	—	—
IX	6	592.00	132.74	198.21	263.96	313.93	352.66	424.20	469.11	514.59	561.31	—
X	2	529.50	106.93	152.12	189.30	238.15	297.46	348.48	401.95	443.75	473.86	508.28
Mean length			120.54	208.95	275.30	329.07	375.26	419.53	457.81	489.67	517.59	508.28
Annual growth increment			120.54	88.41	66.35	53.77	46.19	44.27	38.28	31.86	27.92	
No. of fish			258	258	233	169	87	55	28	14	8	8

The scale method for age and growth studies of *Labeo rohita* has been validated on the criteria laid down by Van Oosten (1929). Annuli were the valid year marks and ages determined by counting annuli were accurate. The scales of this species were also found suitable for calculation of past growth histories.

Determination of age is an essential pre-requisite for the study of population dynamics of any species for fish. The present study has opened a new field of investigation which uptil now was never explored for the fishes of Punjab. It is hoped that future studies conducted along the lines described, will lead to the formulation of a sound management policy of the fishery of this, one of the most important fresh water carps of Punjab. It must be made very clear that to determine age we must now plan to study more elaborately.

The final authenticity of this method will be only confirmed when either 'known age method' (Van Oosten, 1913) or marking experiments were tried. Elucidation of growth, structure and developmental physiology with proper staining techniques demonstrate the areas of fast and slow growth on the scale; such studies as were made by Wallin (1957), if attempted on carps of Punjab, will further enlighten the subject.

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