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European Journal of Experimental Biology, 2015, 5(2):16-21

ISSN: 2248 –9215
CODEN (USA): EJEBAU

Studies on age, growth and age composition of commercially important fish species, *Cirrhinus mrigala* (Hamilton, 1822) from the tributary of the Ganga river, India

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ABSTRACT

Studies were undertaken during the period August 2011 to July 2012 from the lower stretch of the Yamuna river at Allahabad, India. During the present work, 565 fish specimens (274 males and 291 females) were examined for estimation of age, growth increment and age composition of C. mrigala. An over-all picture of age, growth increment and age composition of C. mrigala has been obtained by the study of its scales. The age composition of C. mrigala varied from 0+ to 10+ age group. On the basis of pooled sampled specimen in the length range from 16.8 to 94.3 cm showed that the fish attained the mean length 30.24 cm in 1+, 47.82 cm in 2+, 60.13 cm in 3+, 70.11 cm in 4+, 77.01 cm in 5+, 81.42 cm in 6+, 86.30 cm in 7+, 89.80 cm in 8+, 91.70 cm in 9+ and 94.30 cm in 10+ age groups. The growth increments in C. mrigala was recorded as 30.24 cm, 17.58 cm, 12.31 cm, 9.98 cm, 6.90 cm, 4.41 cm, 4.88 cm, 3.50 cm, 1.90 cm and 2.60 cm for 1+ to 10+ age groups, respectively. The maximum growth increment was recorded in 1st year and moderate in the subsequent years. The minimum growth increment was recorded in 9th year of the life. The slow growth increment observed after second year may be attributed to the maturity attained after second year of life. It is well known that the growth potential is used for the gonad development. The growth percentage varied from age to age in the pooled samples.

Keywords: *Cirrhinus mrigala*, Age composition, age and Growth, Yamuna river.

INTRODUCTION

Cirrhinus mrigala (Hamilton, 1822) is a member of Indian major carp group. The species is of commercial significance due to its aquaculture potential and high consumer preference [1]. Age and growth rates are two attributes of primary importance in accessing fish population and their response to various aspects of management measures [2]. The purpose of growth studies of fish is to determine the amount of fish that can be produced with respect of time. The ability to age of fish accurately is essential in understanding the dynamics of fish population. The annual variation in a fishery depends upon its growth pattern. It is often desirable to segregate catch on the basis of age groups to know the vulnerability of any such group of the fishing gear. Age composition of the catch has often been used in different fisheries of the world to predict the future available stocks. Age composition data on sexes can be precisely used to study the differential growth rates in males and females and in the sample as a whole

[3, 4]. Growth is a complex mechanism, which represents the outcome of the interactions among several biotic and abiotic factors operating on behavioural and physiological processes [5].

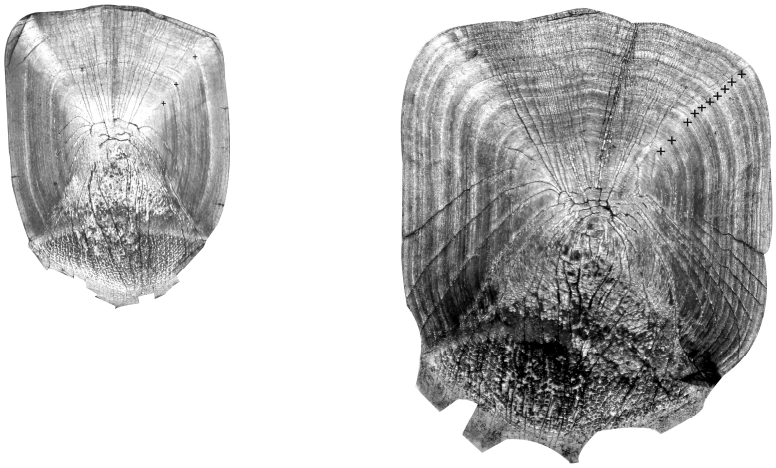
The present study was thus undertaken to estimate age and growth increment of *C. mrigala* from the Yamuna river at Allahabad, India. This study will help in formulation the fishery management policies of *C. mrigala* in the Yamuna river, India.

MATERIALS AND METHODS

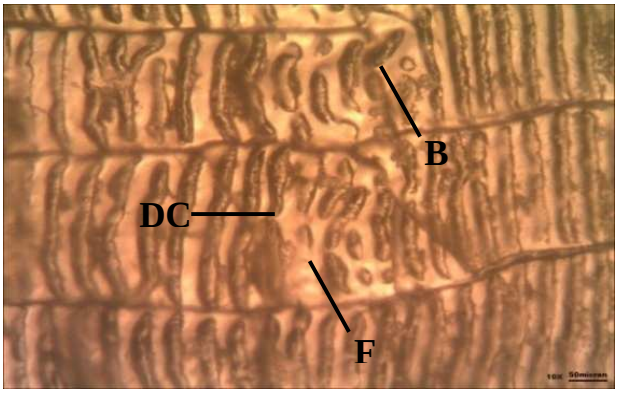
Study was undertaken during the period August 2011 to July 2012. For collection of data, Sadiapur fish market was visited early in the morning. Earlier studies have shown that bulk of the night catches from the lower stretch of river Yamuna is brought to this wholesale fish market for disposal. The key scales [6] were used for determination of the age of *C. mrigala*. The key scales were gently removed with fine forcep from the row above lateral line below dorsal fin region [6, 7]. Immediately after their removal, scales were cleaned mechanically using a fine brush and rinsed with distilled water. The scales were cleaned in 5% KOH solution to remove adhering- tissues and finally washed in distilled water. The scales were then pressed while drying in order to avoid their curling. After proper cleaning of the scales, the counting of growth rings was performed. The age of the fish was determined using Carl Zeiss Jena scale Reader. The ring zone was appeared in opaque format and rest zone was transparent.

RESULTS AND DISCUSSION

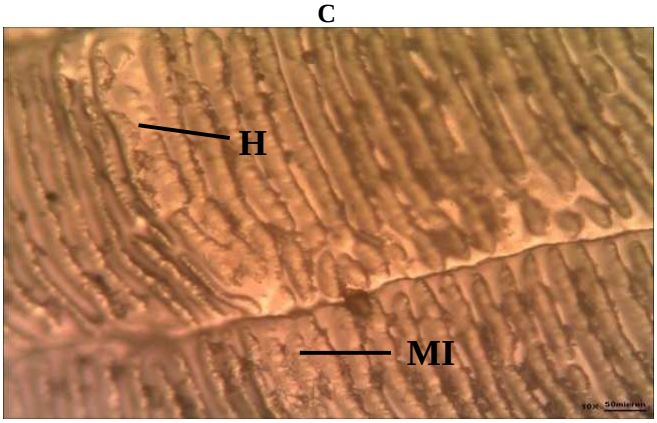
C. mrigala possess typical cycloid scales in the bodies. Hence, scales of these species were similar in structure and consisted of an anterior field (AF), a posterior field (PF), two lateral fields (LF) and a focus (F). The anterior field of the scale remains embedded in the skin, while the posterior field is visible 'in situ' condition. In case of *C. mrigala*, the circuli was not continuous in the immediate vicinity of the focus. They became continuous only after a little distance from the focus in scale of 3+ age group (Plate I A). In fish of higher age groups, circuli around focus appeared to be continuous in immediate vicinity of the focus (Plate I B). In case of lower age groups of *C. mrigala*, the opaque zone comprised of broken and discontinuous weakly deposited and fused circuli (Plate I C). In case of higher age groups, the compact zone comprised hyaline zone and mixed circuli (Plate I D). The formation of transparent and opaque zones was common in all fishes of *C. mrigala*. These uniform (irregular spaced) small compact zones occurred with regularity in the anterior field implying their formation or deposition at regular intervals in fish of different age groups. The opaque zone varied in these species. The compact zones are areas registering check in the growth. In fact the transparent zones represent the beginning of faster growth, whereas the zone of diminished growth is represented by the concentric band of closely packed circuli just inside the transparent zone. They appear as opaque zone when seen under low magnification as circuli are laid close to each other in certain parts of the scale. The transparent and opaque zone appeared quite distinct in scales of larger age groups compared with smaller (<2 age) age groups. Annuli of similar nature have been observed by [8-12].



(A) **(B)**



C



D

Plate I Growth rings (A, B) and structure of growth checks (C, D) in the key scale of *C. mrigala*

Abbreviations

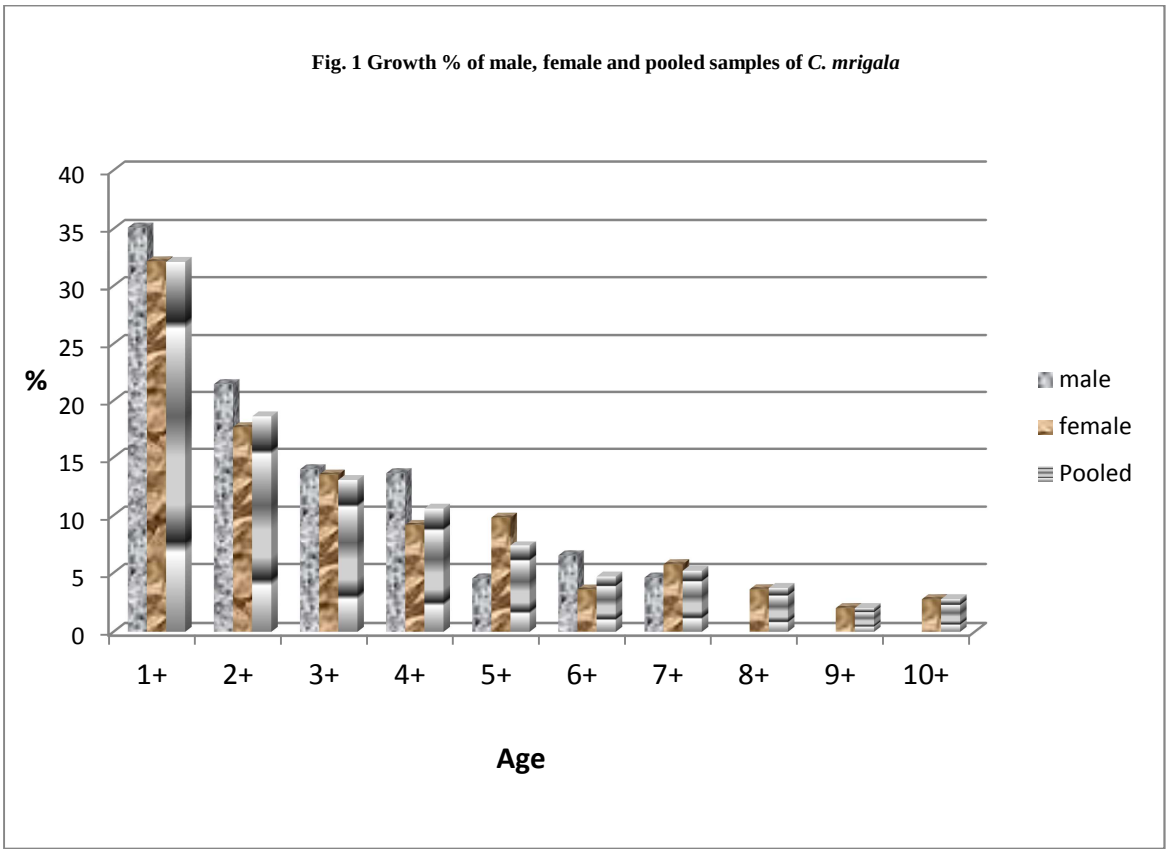
B = broken circuli, DC = discontinuous weakly deposited circuli
F =fused circuli, H = hyaline zone, MI = mixed circuli

During the present work, 565 fish specimens (274 males and 291 females) were examined for estimation of age and growth increment of *C. mrigala*. The first year (1+) growth increment of female fishes higher compared to male while 2+, 3+ and 4+ male fishes showed higher growth increment compared to female.

Table 1Age and growth of *Cirrhinus mrigala* (Pooled) from the Yamuna river at Allahabad

Age	Size range (cm)	Mean length (cm)	Growth increment (cm)	Percentage of growth increment
0+	16.8-25.6	22.14		
1+	22.0-41.5	30.24	30.24	32.07
2+	37.7-58.4	47.82	17.58	18.64
3+	45.8-69.4	60.13	12.31	13.05
4+	64.0-78.0	70.11	9.98	10.58
5+	73.8-80.5	77.01	6.90	7.32
6+	78.2-84.8	81.42	4.41	4.68
7+	85.0-87.2	86.30	4.88	5.17
8+	89.8	89.80	3.50	3.71
9+	91.7	91.70	1.90	2.01
10+	94.3	94.30	2.60	2.76

Fig. 1 Growth % of male, female and pooled samples of *C. mrigala*



Pooled

An over-all picture of growth of *C. mrigala* has been obtained by the study of its scales. The age composition of *C. mrigala* varied from 0+ to 10+ from the lower stretch of the Yamuna river at Allahabad. On the basis of sampled specimen in the length range from 16.8 to 94.3 cm showed that the fish attained the mean length 30.24 cm in 1+, 47.82 cm in 2+, 60.13 cm in 3+, 70.11 cm in 4+, 77.01 cm in 5+, 81.42 cm in 6+, 86.30 cm in 7+, 89.80 cm in 8+, 91.70 cm in 9+ and 94.30 cm in 10+ age groups. The growth increments in *C. mrigala* was recorded as 30.24 cm, 17.58 cm, 12.31 cm, 9.98 cm, 6.90 cm, 4.41 cm, 4.88 cm, 3.50 cm, 1.90 cm and 2.60 cm for 1+ to 10+ age groups, respectively (Table 1). The maximum growth increment was recorded in 1st year and moderate in the subsequent years. Further, this fish follows the general growth pattern i.e. the annual increment decreases with the increase in age which is a characteristic feature of most of the carps. The minimum growth increment was recorded in 9th year of the life. The slow growth increment observed after second year may be attributed to the maturity attained after

second year of life. It is well known that the growth potential is used for the gonad development. The growth percentage varied from age to age in the pooled samples (Fig. 1).

Male

Among the studies, male fish samples length ranged from 16.8 to 86.0 cm. Growth ring was not observed below 23.4 cm size group of fishes. In case of male fishes, only 7 year old fishes were recorded in the Yamuna river at Allahabad. The present observations showed that the fish attained the mean length 30.19 cm in 1+, 48.61 cm in 2+, 60.63 cm in 3+, 72.36 cm in 4+, 76.25 cm in 5+, 82.05 cm in 6+ and 86.00 cm in 7+ age groups. The growth increment in male was recorded 30.19 cm, 18.42 cm, 12.02 cm, 11.73 cm, 3.89 cm, 5.80 cm and 3.95 cm for 1+ to 7+ age groups, respectively (Table 2). The maximum growth increment was recorded in 1st year and minimum in 5th year of the life. The slow growth increment was observed after second years may be attributed to the attainment of maturity during second year of life. It is well known that the growth potential is used for the gonad development. The growth percentage varied from age to age in the male samples (Fig. 1). The higher growth rate in males has been attributed to less energy diverted/required for reproduction and production of gametes in males.

Table 2Age and growth of *Cirrhinus mrigala* (male) from the Yamuna river at Allahabad

Age	Size range (cm)	Mean length (cm)	Growth increment (cm)	Percentage of growth increment
0+	16.8-25.3	22.41		
1+	23.4-41.5	30.19	30.19	35.10
2+	40.0-58.4	48.61	18.42	21.42
3+	45.8-69.4	60.63	12.02	13.98
4+	66.0-78.0	72.36	11.73	13.64
5+	75.0-78.0	76.25	3.89	4.52
6+	81.5-82.6	82.05	5.80	6.74
7+	86.0	86.00	3.95	4.59

Female

The female fishes measured from 17.0 to 94.3 cm in length. The age composition of female *C. mrigala* varied from 0+ to 10+ from the lower stretch of the Yamuna river at Allahabad. The present observations showed that the fish attained the mean length 30.29 cm in 1+, 46.98 cm in 2+, 59.73 cm in 3+, 68.38 cm in 4+, 77.62 cm in 5+, 81.00 cm in 6+, 86.40 cm in 7+, 89.80 cm in 8+, 91.70 cm in 9+ and 94.30 cm in 10+ age groups. Growth ring was not recorded below 22.0 cm size group of fishes. The growth increments in *C. mrigala* was recorded 30.29 cm, 16.69 cm, 12.75 cm, 8.65 cm, 9.24 cm, 3.38 cm, 5.40 cm, 3.40 cm, 1.90 cm and 2.60 cm for 1+ to 10+ age groups, respectively (Table 3). The maximum growth increment was recorded in 1st year of the life cycle and minimum in 9th year of the life. The slow growth increment was observed after second years may be attributed to the attainment of maturity during second year of life. It is well known that the growth potential is used for the gonad development. The growth percentage varied from age to age in the female samples (Fig. 1).

Table 3Age and growth of *Cirrhinus mrigala* (female) from the Yamuna river at Allahabad

Age	Size range (cm)	Mean length (cm)	Growth increment (cm)	Percentage of growth increment
0+	17.0-25.6	21.81		
1+	22.0-39.2	30.29	30.29	32.12
2+	37.7-58.2	46.98	16.69	17.70
3+	51.6-65.5	59.73	12.75	13.52
4+	64.0-72.8	68.38	8.65	9.17
5+	73.8-80.5	77.62	9.24	9.80
6+	78.2-84.8	81.0	3.38	3.58
7+	85.0-87.2	86.4	5.4	5.72
8+	89.8	89.8	3.4	3.60
9+	91.7	91.7	1.9	2.01
10+	94.3	94.3	2.6	2.76

Estimation of accurate fish age is considered as an essential step for age assessment of fish population and successful resource management [13]. Differences in growth may be observed when same species inhabit different rivers of same ecoregion. *C. mrigala* grows well both in the lentic and lotic environments and performs better growth in the old tank with adequate vegetable debris [14]. [15] reported that the mean length of *C. mrigala* at 1 to 12 age from the Ganga river at Allahabad as 290.9 mm in 1, 511.4 mm in 2, 670.5 mm in 3, 797.4 mm in 4, 858 mm

in 5, 888.5 mm in 6, 911 mm in 7, 921.8 mm in 8, 947 mm in 9, 958.25 mm in 10, 958.25 mm in 11 and 992 mm in 12 age groups. Current mean length of *C. mrigala* slower compared to [15] except first year of life. [16] estimated the mean length of *C. mrigala* as 268.0 mm, 458.0 mm, 644.2 mm, 736.1mm, 816.7 mm, 867.1 mm, 924.0 mm and 958.6 mm in 1 to 9 age groups of fishes, respectively from the Yamuna river at Allahabad. He stated that the growth in *C. mrigala* is most rapid during first four years of its life, first year having maximum growth. The gradual decrease in growth rate is observed during later years until a limiting value of total length (ultimate length) is approached.

[17] reported the growth of *C. mrigala* as 275 mm, 480 mm, 630 mm, 750 mm, 840 mm, 873 mm, 900 mm 913 mm and 920 mm at age groups I, II, III, IV, V, VI, VII, VIII and IX, respectively. The growth increment in the first three years of life was relatively high, which decreased gradually up to age group VII, and became slow for age groups VIII and IX. While that from the Godavari river 230, 358, 470, 48, 580, 676, 760, 828 and 885 mm for 1 to 8 age groups [18]. The lengths-at-age for *C. mrigala* from similar as well as different ecoregion were reasonably similar to the present observation. [19] reported the mean length as 210, 384, 514, 602 and 695 mm in 1 to 5 age group fishes of *C. mrigala* from the Rihand reservoir.

[20] recorded mean length as 44.21, 48.62, 51.24, 70.83 77.25 and 83.00 cm in 3+ to 8+ age groups of *C. mrigala* in the Pong reservoir, Himachal Pradesh. The annual increment in the age class 3 was 7.48 cm followed by 6.37, 6.56, 6.50, 10.02, 7.12 and 6.09 cm in the age classes 4, 5, 6, 7 and 8, respectively.

It may be concluded that the fish growth was slow compared to earlier reports. Age composition was also declined.

Acknowledgement
The authors are highly thankful to Vice-Chancellor, Nehru Gram Bharti University, Kotwa-Jamunipur Allahabad for providing facilities. The authors are also thankful to Head, CIFRI Allahabad for guidance and suggestions in the preparation of documents.

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