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Size Selectivity of Active Fishing Gear: Changes in Size, Age and Growth of Cirrhinus Mrigala from the Ganga River, India

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Abstract

Good knowledge of netting approach is essential for scientific and sustainable based fisheries management in lotic water bodies. The large sizes of fishes are more attract to fishers compared to small fishes. This type of fishing is very harmful for future stock and recruitment. 1.5 inch to 3.5 inch mesh size cast net was used in the Ganga River at Allahabad. *Cirrhinus mrigala* is mainly captured by drag net from the Ganga River, India. Studies were undertaken during March 2014 to February 2015 from the middle stretch of the Ganga River, India. 423 fish specimens (206 males and 217 females) were examined of *Cirrhinus 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+. On the basis of pooled sampled specimen in the total length ranges varied from 16.8 cm to 92.4 cm showed that the fish attained the mean length 30.24 cm, 48.02 cm, 61.50 cm, 70.31, 77.63, 81.84 cm, 85.30 cm, 88.57 cm, 90.15 cm, 91.8 cm in 1+, 2+, 3+, 4+, 5+, 6+, 7+, 8+, 9+ and 10+ age groups respectively. The growth increments in *C. mrigala* was recorded as 30.24 cm, 17.78 cm, 13.48 cm, 8.81 cm, 7.32 cm, 4.21 cm, 3.46 cm, 3.27 cm, 1.58 cm and 1.65 cm for 1+ to 10+ age groups, respectively. The maximum growth increment was recorded in 1st year and minimum in 9th year of life. The slow growth increment observed after third 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. Drag netting is reducing the size of *C. mrigala* in the Ganga River.

Keywords: Active fishing gear; Exploitation; *Cirrhinus mrigala*; Age; Growth; Ganga River

Introduction

Fisheries of the Ganga river basin are very vital for the livelihood of fishers/fishermen near the river bank and fish sellers, India [1]. Ensuring that riverine fisheries are managed to provide ecosystem services that benefits human being and also maintaining food security of the local level and nations [2,3]. The river ecologists have been interested to build out of differences in fishery and fishing composition and occupation of water bodies from stretch to stretch. Understanding the ecological environment and function of natural or altered riverine ecosystems is the common goal of many river, stream and reservoir studies. Fishing net is a net used for harvesting of fishes (example fishing). There are two types of net that have been used in the water bodies such as active and passive net. All fishing gears exhibit some degree of selectivity in the sizes or species (or both) of fishes collected. The term active means that the fishing gear is dragged through the water bodies by person, mammal or engine power. Active fish capture methods use moving nets or gears to collect finfishes as well as shellfishes and other economically important macro invertebrates. In most cases the efficiency of active gear is considerably higher than that of passive gear, such as gill nets, long lines and traps, which rely for their efficiency on the movement of the fish themselves [4].

Finfishes and shellfishes are significant foundation of proteins, in present scenario they are affected by rapid commercialization and industrialization of the globe [5,6]. First 1000 days (for children), fish consumption is important to prevent malnourishment and support cognitive development [7]. *Cirrhinus mrigala* is a member of Indian major carps group (example *Catla catla, Labeo rohita, Cirrhinus mrigala*). It is large size herbivorous fish species. It is back bone of culture fishery in Indian subcontinents (example India, Bangladesh, Pakistan, Nepal etc.). It is also shared maximum contribution in capture fishery in Indian major carp group [8,9]. The natural distribution of *C. mrigala* is in the freshwaters of India, Bangladesh, Pakistan and Burma. Along with other Indian major carps it had been successfully extensively spread to Nepal, Malaysia, Sri Lanka, Japan, Mauritius, Philippines, south Rhodesia, U.S.S.R., Africa and Vientiane [10]. Their ecological conditions and life history behaviour make them a successful invader. Traits enhancing the invasiveness of *C. mrigala* is their high cultural ability, high reproductive performance and easy breeds in hatchery, being extremely adaptable and opportunistic in habitat preferences and diet. The species is of commercial significance due to its aquaculture potential and high consumer preference [8,11].

Age and growth rates are two attributes of primary importance in accessing fish population and their response to various aspects of management measures [3,9]. 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 find the 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 [12,13]. Growth is a complex mechanism, which represents the outcome of the interactions among several biotic and abiotic factors operating on behavioural and physiological processes

[14]. Human activities have strongly altered size, age and sex ratio of fishes from the freshwater ecosystems over the world. The present study was thus undertaken to estimate age and growth increment of *C. mrigala* in respect of fishing gear from the Ganga River at Allahabad, India. This study will help in formulation the fishery management policies of *C. mrigala* in the Ganga River, India.

Materials and Methods

1.5 inch to 3.5 inch mesh sizes of cast net was used in the Ganga River at Allahabad. Each and every cast net have 2/3 category of mesh sizes. In general, in a single casts net there are different mesh sizes have been used i.e. 1.5, 2.0, 2.5, 3.0 and 3.5 inches. The length and width of cast net was also varied from 10 m to 50 m in the Ganga River, India. The main data was collected from the fish market. The experimental fishing was also approaches for present study with help of 30 meter drag net in summer, winter and monsoon seasons.

The total length of fishes varied from 16.8 cm to 92.4 cm from the Ganga River. Scales of fishes are remarkable structures. Much information can be obtained about the growth history and longevity of individual fish by close examination of their scales. On the population level, also, age and growth is an excellent index to wellbeing. The number of scales covering the body remains constant throughout life, and in universal, scale growth is proportional to fish growth.

Study was undertaken during the period March 2014 to February 2015. For collection of data, Teliearganj fish market was visited. About 25 km stretch of the river catch is disposed at Teliearganj fish market. The key scales [15] were used for determination of the age of *C. mrigala*. The key scales were gently removed with fine forceps from the row above lateral line below dorsal fin region (especially 3rd or 4th rows) [15,16]. 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

Drag net (1.5 inch to 3.5 inch mesh size) is mainly use for netting of *C. mrigala* from the middle stretch of the Ganga River, India. The net length, width and mesh size are totally dependent on the economic status of the fishers/fishermen. The large size of *C. mrigala* is mainly fished by higher class fishers. Older and larger individuals are mainly harvested (e.g. *Catla catla, Labeo rohita, C. mrigala*) by drag net. *C. mrigala* is continually overfished in the Ganga River and its tributaries [17]. Fishing generally decreases the density of large adults, which can increase the absolute and relative densities of juvenile [18]. Heritable behavioural traits might be under strong selection in capture fishery [19]. In case of drag net, no chance for escape to large size fishes in the Ganga River especially winter and monsoon seasons. In these season environmental flow are very poor. *C. mrigala* is bottom feeder fish. Swimming style is also responsible for chance of capture potential [1,3,20,21].

C. mrigala is a fast growing and highly preferred food fish in India. It has also gained popularity in other south-east Asian countries. *C. mrigala* possess typical cycloid scales in the bodies. 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 fish of higher age groups, circuli around focus appeared to be continuous in immediate vicinity of the focus. As a fish becomes older, growth rate slows down and annuli become closer together (Plate 1).

During the present work, 423 fish specimens (206 males and 217 females) were examined for estimation of age and growth increment of *C. mrigala*. The first year (1+) growth rate of female fishes were higher compared to male while 2+, 3+ 4+, 5+, 6+, 7+, 8+ and 9+ age groups male fishes were showed higher growth rate compared to female.

Pooled

The age composition of *C. mrigala* varied from 0+ to 10+ from the middle stretch of the Ganga River, India. On the basis of pooled sampled specimen in the length range from 19.2 cm to 92.4 cm showed that the fish attained the mean length 30.24 cm in 1+, 48.02 cm in 2+, 61.50 cm in 3+, 70.31 cm in 4+, 77.63 cm in 5+, 81.84 cm in 6+, 85.30 cm in 7+, 88.57 cm in 8+, 90.15 cm in 9+ and 91.8 cm in 10+ age groups (Table 1). The growth rate in *C. mrigala* was recorded as 30.24 cm, 17.78 cm, 13.48 cm, 8.81 cm, 7.32 cm, 4.21 cm, 3.46 cm, 3.27 cm, 1.58 cm and 1.65 cm for 1+ to 10+ age groups, respectively (Figure 1). The maximum growth rate 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 third 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.

Male

The male fish's samples length ranged from 16.8 cm to 92.4 cm. Growth ring was not observed below 21.2 cm size group of fishes. In case of male fishes, only 9 year old fishes were recorded in the Ganga River at Allahabad, India. The present observations showed that the fish attained the mean length 28.79 cm in 1+, 47.21 cm in 2+, 62.03 cm in 3+, 73.63 cm in 4+, 80.45 cm in 5+, 85.32 cm in 6+, 88.74 cm in 7+, 90.68 cm in 8+ and 92.4 cm in 9+ age groups (Table 1). The growth rate in male was recorded 28.79 cm, 18.42 cm, 14.82 cm, 11.60 cm, 6.82 cm, 4.87 cm, 3.42 cm, 1.94 cm and 1.72 cm for 1+ to 9+ age groups, respectively (Figure 1). The maximum growth rate was recorded in 1st year and minimum in 9th year of the life. The slow growth rate was observed after third 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 Figure 1. The higher growth rate in males has been attributed to less energy diverted/required for reproduction and production of gametes in males.

Age groups	Size ranges (cm)			Mean length (cm)		
	Male	Female	Pooled	Male	Female	Pooled
0+	16.8 - 24.7	19.2 - 27.6	16.8 - 27.6	20.13	21.45	20.84
1+	21.2 - 39.6	23.5 - 38.4	21.2 - 39.6	28.79	31.74	30.24

2+	37.5 - 57.7	37.7 - 58.2	37.5 - 58.2	47.21	48.98	48.02
3+	53.4 - 67.4	51.6 - 65.5	51.6 - 67.4	62.03	60.23	61.5
4+	65.2 - 76.3	64.0 - 72.8	64.0 - 76.3	73.63	69.18	70.31
5+	75.0 - 83.0	73.8 - 80.3	73.8 - 83.0	80.45	75.62	77.63
6+	82.8 - 87.6	78.2 - 82.4	78.2 - 87.6	85.32	80	81.84
7+	86.0 - 89.2	83.2 - 86.0	83.2 - 89.2	88.74	84.4	85.3
8+	90.2 - 91.6	85.7 - 88.9	85.7 - 91.6	90.68	87.8	88.57
9+	92.4	88.4 - 90.7	88.4 - 92.4	92.4	89.7	90.15
10+	-	91.8	91.8	-	91.8	91.8

Table 1: Mean length of male, female and pooled samples of *Cirrhinus mrigala* from the Ganga River.

Female

The female fishes measured from 19.2 to 91.8 cm in length. The age composition of female *C. mrigala* varied from 0+ to 10+ from the middle stretch of the Ganga River at Allahabad, India. The present observations showed that the fish attained the mean length 31.74 cm in 1+, 48.98 cm in 2+, 60.23 cm in 3+, 69.18 cm in 4+, 75.62 cm in 5+, 80.00 cm in 6+, 84.40 cm in 7+, 87.80 cm in 8+, 89.70 cm in 9+ and 91.80 cm in 10+ age groups. Growth ring was not recorded below 19.2 cm size group of fishes (Table 1). The growth rate in *C. mrigala* was recorded 31.74 cm, 17.24 cm, 11.25 cm, 8.95 cm, 6.44 cm, 4.38 cm, 4.40 cm, 3.40 cm, 1.90 cm and 2.10 cm for 1+ to 10+ age groups, respectively (Figure 1). The maximum growth rate was recorded in 1st year of the life cycle and minimum in 9th year of the life. The slow growth rate 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.

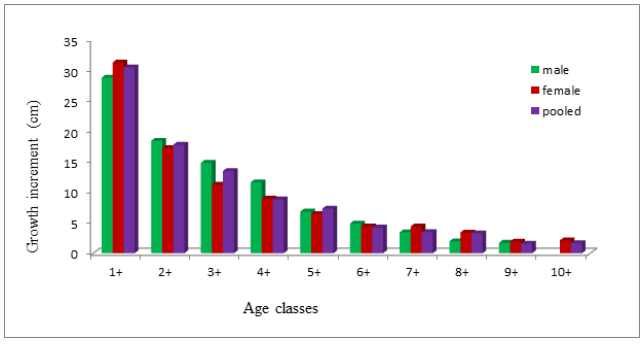

Figure 1: Growth rate of *Cirrhinus mrigala* (male, female, Pooled) from the Ganga River, India.

Fishing gear (example drag net) can change the living and non-living environment within which the target and other related resources live. Fishing may also affect ecological processes at very large scale. Fishing pressure is changes the size structure, age and stock of the fish species [20-24]. They also modify sex ratio, genetics and species composition of the target resources, as well as of their associated and dependent species [22,25,26]. *C. mrigala* is over exploited in the Ganga and Yamuna rivers [3,9,27]. The fishing pressure is main cause of decline in production, size and age of fishes in water bodies [28]. In general, fishes are mainly over exploited in winter and summer seasons by drag netting, in India. Mature *C. mrigala* is maximum caught in monsoon season due to breeding habits. In breeding season, fishes (example male and female) are more active compared to non-breeding season. The fishermen are also more active in monsoon season. The landing of *C. mrigala* is also increases in monsoon season at Allahabad site [3].

Estimation of accurate fish age is considered as an essential step for age assessment of fish population and successful resource management [29]. 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 [10]. Jhingran [30] reported that the mean length of *C. mrigala* at 1 to 12 age from the Ganga river at Allahabad as 290.9 mm, 511.4 mm, 670.5 mm, 797.4 mm, 858 mm, 888.5 mm, 911 mm in, 921.8 mm, 947 mm in, 958.25 mm, 958.25 mm and 992 mm in 12 age groups, respectively. Current mean length of *C. mrigala* is lower compared to [30] except first year of life. Kamal [31] estimated the mean length of *C. mrigala* as 268.0 mm in 1, 458.0 mm in 2, 644.2 mm in 3, 736.1 mm in 4, 816.7 mm in 5, 867.1 mm in 6, 924.0 mm in 7 and 958.6 mm in 8 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. The existing maximum length of *C. mrigala* is lower compared to earlier reports by [30-32].

The alteration of the habitat by various human activities may be physical (e.g. dam and road construction etc.), mechanical (example alteration of water flow), or chemical (hormones, drugs, injection of nutrients, pesticides, insecticide, heavy metals, industrial influents) [33-36]. Fishing activities may result in changes in productivity of resources (some positive and more negative) and affects associated species. Worldwide fishery resources are facing a number of threats, which have principally been attributed to commercially and mechanically exploitation [3,27,37].

Age and growth rates are two attributes of primary importance in accessing fish population and their response to various aspects of management measures. Mayank [38] was recorded the age composition of *C. mrigala* from 0+ to 10+ age group from the Yamuna river, India. She recorded 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 while the growth increments was observed 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. Khan [29] 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 [39]. The lengths-at-age for *C. mrigala* from similar as well as different ecoregion were reasonably similar to the present observation. Parmar and Bhatia [40] 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 4, 5, 6, 7 and 8 age classes, respectively.

Fishing pressure and fishing style (example degree) are also responsible for decreasing of age, size of fishes and recruitment (example damage breeding ground) in lotic ecosystems [41-46]. These factors are significantly altered to food security policy [47,48] and abundance [49-52]. Non-native fishes are also changed selectivity of gear due to nature, dwelling behaviour and ecological condition [53-55]. Non-native fishes are helping for homogenization of faunas, increasing of diversity [56,57] and create pressure for native species [58-60].

It may be concluded that the selectivity of gear altered the age and size of fishes from the Ganga river. The size of Indian major carp *C. mrigala* has declined. The river Ganga is known as original adobe of the valuable Indian major carp. The seasonal variation is also highly monitored to the fishing activity from the river. *C. carpio* and *O. niloticus* species are provide proper occupation and food security to fisher community from the Ganga River at Allahabad, India. For the health of the river and native fish stock restoration is very urgently need for Indian major carp at Allahabad, India.

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