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Shyamal Chandra Sukla Das

(1) Regional Centre, ICAR-Central Inland Fisheries Research Institute, 24- Panna Lal Road, Allahabad, Uttar Pradesh, India

(2) ICAR- Central Institute of Fisheries Education Panch Marg, Off Yari Road, Mumbai, Maharashtra, India

Kripal Datt Joshi

ICAR-National Bureau of Fish Genetic Resources, Lucknow, Uttar Pradesh, India

SK Chakraborty

ICAR- Central Institute of Fisheries Education Panch Marg, Off Yari Road, Mumbai, Maharashtra, India

Debabrata Panda

ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, Odisha, India

AK Jaiswar

ICAR- Central Institute of Fisheries Education Panch Marg, Off Yari Road, Mumbai, Maharashtra, India

Correspondence**AK Jaiswar**

ICAR- Central Institute of Fisheries Education Panch Marg, Off Yari Road, Mumbai, Maharashtra, India

Length-weight relationship and condition factor of *Cyprinus carpio* Linnaeus, 1758 from the river Ganga, Allahabad, India

Shyamal Chandra Sukla Das, Kripal Datt Joshi, SK Chakraborty, Debabrata Panda and AK Jaiswar

Abstract

The study established the length-weight relationship and condition factor of *Cyprinus carpio* from the river Ganga. Fish samples of 342 having a size of 9.0 cm to 689 mm were studied to establish the length-weight relationship. The length-weight relationship was established as $W = 0.03576 TL^{2.749815}$, $W = 0.03266 TL^{2.786091}$ and $W = 0.032738 TL^{2.780554}$ for male, female and combined sex, respectively. The correlation coefficient (r) was highly significant for male and female, indicating a strong correlation between length and weight ($r = 0.91$; $p < 0.001$). The regression coefficient a and b were highly significant in both the sexes ($p < 0.001$). The t test depicted clear deviation from the isometric pattern of growth ($b = 3$) in male ($t = 5.25$, $p < 0.05$), female ($t = 5.17$, $p < 0.05$) and pooled data ($t = 7.03$, $p < 0.05$). Negative allometric growth pattern ($b < 3$) was observed in male, female and combined sex. The average condition factor was higher in female than male in all months and > 1.0 for male and female, which clearly showed better dwelling condition of the species around the year. The mature common carps were found in all the months. This research could be used to guide to study the ecology and biology of common carp, which may serve as tools for management and conservation of this resource.

Keywords: Length-weight relationship, common carp, condition factor, ganga river, allometric growth

Introduction

The common carp (*Cyprinus carpio* Linnaeus, 1758) is large bodied cyprinid and world's most widespread and ecologically detrimental invasive freshwater fish [1]. The species has been introduced to more than 100 countries outside its native range [2]. In India, it was first, imported in 1939 from then Ceylon and was transplanted in Nilgiri and another variety (scale carp) was brought from Bangkok to Cuttack (Orissa) in 1957 for aquaculture. The Bangkok strain (*Cyprinus carpio communis*) and mirror carp (*Cyprinus carpio specularis*) are widely used under aquaculture in plains and in upland waters of hill states, respectively. The common carp has augmented fish production [3] in the country and is cultivated in different agro-climatic conditions. There are more than 300 exotic fish species in India. Many of them (particularly *Cyprinus carpio*) escaped from confinement and are now present in the Ganga River, challenging its ecological equilibrium [4]. The species is well established in the Ganga River. The length-weight relationship has important applications in the areas of fisheries management and fish biology. The relationship facilitates the growth studies, calculation of condition indices, and estimation of length from the weight, estimation of weight at age, life-history evaluation, and morphological comparisons of interspecific and intraspecific populations inhabiting different habitats and or region [5-8]. In fishery biology, it is essential to make use of length-weight relationship to differentiate the weight of known groups from expected one and forecast breeding, feeding state, fatness and suitability of environment [9]. These are fundamental to the population dynamic studies and assessment of fish stocks [10]. The relative condition factor (K_n) indicates the suitability of the water body for the growth of fish [11]. Recent studies on the length-weight relationship and condition factors in important fish species are well documented; some of those include that of [12-18]. In India, Length-weight relationship and condition factor of *Cyprinus carpio* were documented mainly from the lentic water bodies [19-24] and elsewhere [25-27]. However, there is scarce literature available on length-weight relationship and condition factor of *Cyprinus carpio* from the river Ganga at Allahabad stretch where the species have reported to be established from the year 2002 [28].

In the present study, an attempt has been made to establish the length-weight relationships and condition factor of *Cyprinus carpio* from the river Ganga at Allahabad, India.

Materials and Methods

During the present study fish samples of *Cyprinus carpio* were collected from the commercial catches of the river Ganga i.e. from Daraganj (N 25°26'37" & E81°52'54") and Teliyarganj (N25°29'54" & E81°51'39") fish landing center, between September 2016 to August 2017, Allahabad (Fig 1). Total length and weight were measured to the nearest 0.1cm and 0.1g, respectively. The observed values for the length and the weight of each specimen were converted into natural logarithmic values and the length-weight relationship was established as per [11].

$$W = a L^b$$

The relationship was represented below in linear logarithmic form as:

$$\ln W = \log a + b \ln L$$

Where, "L" is the total length of the fish samples in centimeters (cm), "W" total weight of the fish samples in gram (g), "a" is the intercept and "b" is the regression

coefficient.

The regression coefficients of the sexes were compared by the analysis of covariance [29]. The significance of difference, in the estimate of 'b' in males, females and pooled data of sexes from the expected value of 3 (isometric growth) was tested by the equation of [30].

$$t = \frac{sd \ln L}{sd \ln W} * \frac{|b - 3|}{\sqrt{(1 - r^2)}} * (\sqrt{(n - 2)})$$

Where, n = sample size, sdln L and sdlnW are standard deviations in total length and body weight, b = regression coefficient and r² = coefficient of determination. The t- value was compared with the t-table value at 5% significance level for n-2 degrees of freedom. Relative The condition factor (Kn), a measure of well-being of the fishes, was estimated following.

$$Kn = \frac{w}{(L)^3} * 100$$

Where 'w' is the observed weight of the fish in grams and 'L' is the total length in cm. All the above mentioned statistical data analysis were carried out using MS-Excel.

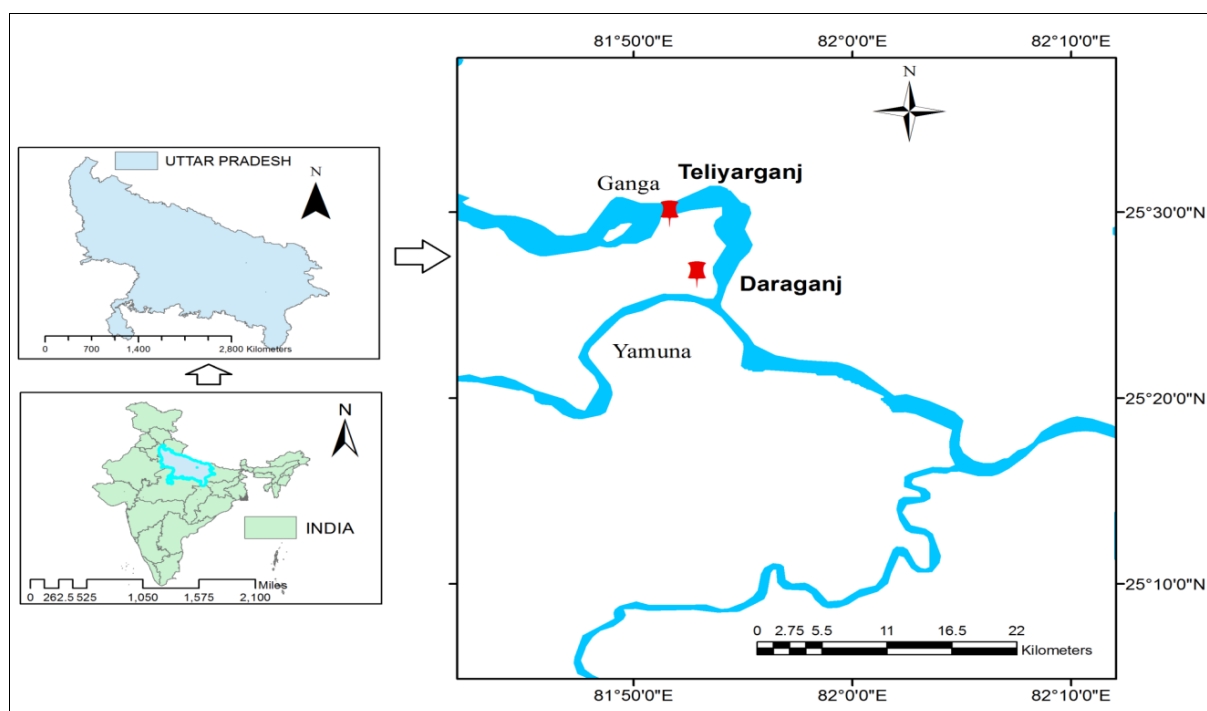


Fig 1: Map showing the fish landing center (Teliyarganj and Daraganj) on the bank of river Ganga at Allahabad

Result and Discussion

During the period investigation, the total length and body weight of 342 samples comprising of 187 males and 155 females of *C. carpio*, collected from the river Ganga at Allahabad, were measured. The total length & weight of the fishes ranged from 11.7 to 53.0 cm & 38.0 to 2100 g for male and 9.0 to 68.9 cm & 12.0 to 5050g for female, respectively. The mathematical relationship between total length and weight of male and female of *C. carpio* obtained by logarithmic equation are as follows-

Male: $\ln W = 2.749815 \ln TL - 3.33091 (R^2=0.947)$

Female: $\ln W = 2.786091 \ln TL - 3.42143 (R^2=0.967)$
 Pooled: $\ln W = 2.780554 \ln TL - 3.41923 (R^2=0.958)$
 Their corresponding power equations can be expressed as-
 Male: $W = 0.03576 TL^{2.749815} (R^2=0.947)$
 Female: $W = 0.03266 TL^{2.786091} (R^2=0.967)$
 Pooled: $W = 0.032738 TL^{2.780554} (R^2=0.959)$

Scatter diagrams of length and weight relationship for male, female and sexes pooled are shown in Fig 2, 3 and 4, respectively.

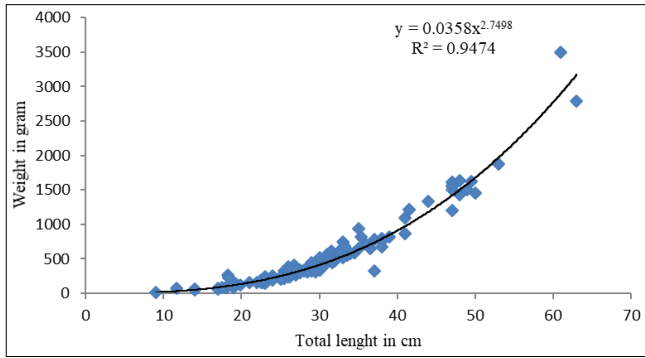


Fig 2: Length-weight relationship in *Cyprinus carpio* (male)

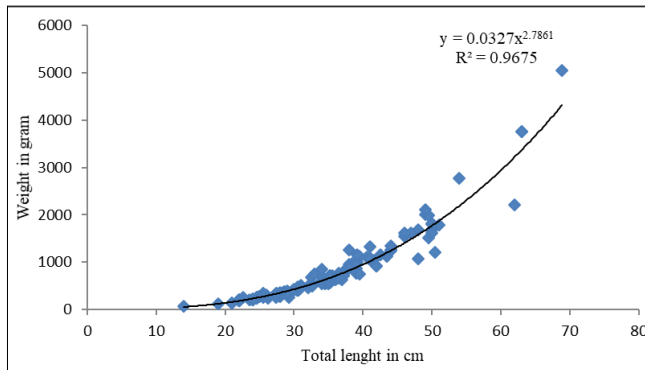


Fig 3: Length-weight relationship in *Cyprinus carpio* (female)

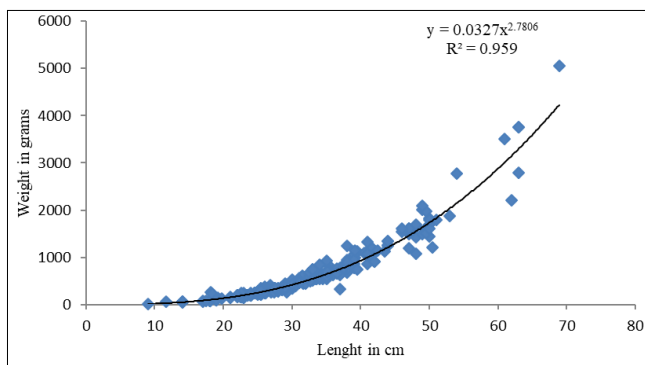


Fig 4: Length-weight relationship in *Cyprinus carpio* (pooled)

The correlation coefficient (r) was highly significant for male and female indicating a strong correlation between length and weight ($r = 0.91$; $p < 0.001$). The regression coefficient a and b were highly significant in both the sexes ($p < 0.001$). The t test depicted clear deviation from the isometric pattern of growth ($b = 3$) in male ($t = 5.25$, $p < 0.05$), female ($t = 5.17$, $p < 0.05$) and pooled data ($t = 7.03$, $p < 0.05$). This indicated negative allometric growth pattern ($b < 3$) in male, female and combined sex of the species. The b values were found to be less than 3, thus not satisfying the cube law. This indicates that the weight of the fish increases in proportion less than the cube of its lengths. Similar kind of negative allometric growth pattern in *C. carpio* have been reported from the composite fish culture system of Himachal Pradesh with b values of 2.9002 [19], inland open water system like Gobindsagar with b value of 2.42 [21], Dal lake with b value of 2.98 [22]. A similar trend was reported by [25] from Lake Naivasha, Kenya, where the b value of 2.3484 & 1.9455 were observed for male and female, respectively. A negative allometric growth pattern was also reported in the Little Zab river of Northern Iraq [26]. The b value, between 1.03 and 3.543 were observed in the middle and southern Iraq provinces exhibiting both negative

and positive allometric growth pattern [27]. The positive allometric growth was reported in *Cyprinus carpio* from the tropical lake and bheries of South 24 Parganas district in West Bengal [20, 23]. The b values above 3 indicate positive allometric growth, where fish becomes heavier for its length while b values below 3 mean that the fish becomes lighter for its length therefore negative allometric growth [31]. The ' K_n ' value in female ranged from 1.51 (June) to 1.64 (April and May) while in the male it ranged from 1.48 (June) to 1.61 (March) (Fig. 5). On average, these values were found to be higher in female (1.58) than in male (1.54) in almost all months. The condition factor of both sexes was found to be > 1 . This shows that the fish is good condition. It was observed that the common carp showed two peaks in ' K_n ' during November-December and May-June in the river Ganga at Allahabad, it might be due to the higher gonadal development during the months, a similar observation was noticed elsewhere [23].

The low ' K_n ' values for the female may be attributed to low gonad maturity. The observation is similar to that of [32] and suggested that a larger part of the energy is allocated for growth and emptying of ovaries leading to relatively lower ' K_n ' values. The difference of the ' K_n ' values between males and females may be attributed to metabolic strain during maturation or spawning as well as changes in feeding activity. A similar condition was observed in several species of fish by earlier workers [33-36]. The variation in the condition of fish in the present study could be attributed to maturity along with food and feeding habits of fish and is in agreement with the earlier works on different fishes [23, 37, 38,]. In the present investigations, it was observed that the brood of common carp was found in all most all samplings months as a result, the ' K_n ' value was showed a higher level during the study period.

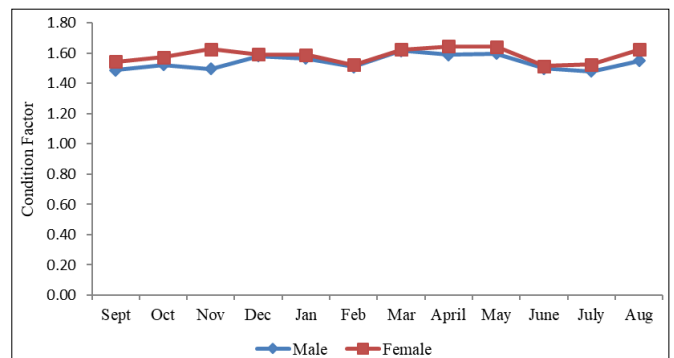


Fig 5: Month-wise condition factor (K_n) in *Cyprinus carpio* from the Ganga River at Allahabad

Conclusions

The present study revealed that the common carp from the river Ganga at Allahabad shows allometric growth pattern. The length-weight relationship was established as $W = 0.03576 TL^{2.749815}$ male and $W = 0.03266 TL^{2.786091}$ female. The availability of mature common carp during all most of all the months. The condition factor of both males and females was greater than 1, which shows that the fish is above average condition. This research builds on existing knowledge, which may serve as important biological information for management and conservation practices.

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