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Length weight relationship and condition factor in different age groups of *Labeo dero* from stream in Sunderbani, Jammu

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Abstract
In the present studies, Length-weight relationship of *Labeo dero* (Family: Cyprinidae) was studied on about 300 specimens (ranging from 3.1cm to 27.5 cm Total length and 0.43gm to 200.10 gm of Body Weight). The value of correlation coefficient indicated a highly significant correlation between length and weight in all the age groups. It was 0.978 in age group 0^+, 0.999 in age group 1^+, 0.995 in age group 2^+, 0.983 in age group 3+ and 0.995 in pooled data of all age groups. The parabolic equation obtained were $W= 0.11480L^{2.756}$, $W= 0.00575L^{3.149}$, $W= 0.00395L^{3.319}$ and $W=0.04920L^{2.521}$ in 0^+, 1^+, 2^+, 3^+ age groups respectively. The condition factor (K) also varied in different age groups was found to be decreasing with advancing age viz. 1.2268, 1.1015, 1.1008, 1.0343 in 0^+, 1^+, 2^+ and 3^+ age groups respectively.

Keywords: length-weight relationship, correlation, condition factor

Introduction
In fishery science, Length-weight relationship studies for a given species are very useful in many ways. Length-weight relationship has been commonly used for two main purposes. Firstly, it primarily meant to facilitate the conversion of one measurement to another and helps in yielding equation /mathematical model between the length and weight so as to derive one from the other (Beverton & Holt, 1957) [1] for population strength. Secondly, to compute the departure from expected weight for the length of individual fish or a group of fishes as indicator of fatness or degree of well being of fish. This relationship is called "Condition factor" (Wooten, 1990) [2]. Further, Length-weight relationship finds significance in assessment of the growth of fish in different environment (Mirza *et al*., 1988) [3]. It also helps us to know the type of growth (Allometric or Isometric). However, there is a general expectation that the weight increases as a cube of the length (Rousenfell & Everhart, 1953; Brown 1957) [4, 5]. But as the fish passes through several stages, the simple cube law doesn't hold well throughout the lifespan and regression coefficient (b) shows certain variations (Martin, 1949) [6]. Therefore to have an exact picture, an age wise study was carried out on length-weight relationship and condition factor of *Labeo dero* from stream in Sunderbani. Earlier many reports are available on length-weight relationship in different fish species (LeCren, 1951; Johal & Tandon, 1981, Zakaria *et al*., 2000; Olurin, 2002; Gupta, 2005; Gandotra *et al*., 2008; Gandotra *et al*., 2009; Kanwal & Pathani; 2011, Rawal *et al.*, 2013; Adeboyejo, 2016; Pawar *et al*., 2017) [7-17].

Materials and Methods
The fishes were from the stream in Sunderbani, (Latitude 33.03°N and Longitude 74.29°E) located at a distance of 79 km from Jammu. Fishes were captured from their natural habitat with the help of cast net, drag net, hand/dip net and other local contrivances. Fishes were further transported to the laboratory where they were weighed after soaking water with the help of bloating paper for further analysis.
Multiple regression analysis was done in the different age groups viz., 0^+, 1^+, 2^+ and 3^+ to compute the degree of relationship between length and weight.
Statistical Length-weight relationships was established using the following formula

$$W = a Lb$$

Where, W is total body weight (g), L the total length (cm), 'a'and 'b' are the coefficients of the functional regression between W and L (Le Cren, 1951). From practical purpose, this relationship is usually expressed in its logarithmic form:

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

The correlation coefficient 'r' was calculated by using standard statistical methods.
The Conditions factor was determined by the formula

$$K = \frac{W \times 100}{L^3}$$

Where L = length in cm and W = weight in gm.
Age determination was done by counting the rings/annulii on the scales which were taken from second or third row beneath the origin of dorsal fin just above the lateral line (Johal & Tandon, 1985; Rawat & Nautiyal, 1996) [18, 19].

Results and Discussion
Length-weight relationship
Based on the study of scales, all the 300 specimens of fish were grouped into different age groups. It was observed that

first growth ring/annulus formation started at 10.2cm TL and was observed up to 16.5 cm TL. Therefore fishes from 10.2-16.5 cm TL with mean total length 13.35± 3.15cm were grouped as 1^+age group. The fishes from 16.6 cm to 21.1 cm with mean 19.35± 2.75 cm TL showed the presence of two growth rings and was grouped as 2^+ age group. Similarly, fishes from 21.2 cm to 27.5 cm with mean 24.85 ±2.65cm TL were grouped as 3^+ age group due to the presence of three growth rings. (Table- 1)

As inferred from Table 2, a high degree of correlation was observed in all the case viz. 0.978(in age group 0+), 0.999(in age group 1+), 0.995(in age group 2+), 0.983(in age group 3+) and 0.995 (in pool data of all age groups).

During present investigation, the values of regression coefficient (b) for all the four different age groups lies between 2.5 to 3.3 and were observed to be 2.756 (in age group 0+), 3.149(in age group 1+), 3.319 (in age group 2+), 2.521 (in age group 3+) and 3.170 (in pool data of all age groups). It was observed from scatter diagram that weight bears a curvilinear relationship with length which becomes linear after transformation into logarithmic (Fig 1). The value of regression coefficient is deviated and is not exactly equal to '3'. Deviation from the value of regression coefficient (b) from '3' has been reported by a number of authors in Labeo species. Pioneer work by Torres (1992) [20], who investigated Lake Kariba, Zambia for length-weight analysis of four species of Labeo and observed exponent value 'b' to be ranged between 2.976- 3.325 for L. altivelis and L. cylindricus respectively, thus indicating negative and positive allometric growth. Rawal *et al.*, (2013) [15] reported, the value of exponent 'b" was 2.98 in *Labeo dero* from Nangal wetland, Punjab, India. Pawar (2017) [17] in *Labeo rohita* observed (b = 2.664 for female to 2.695 for male).

However, the value of exponent 'b' was observed to be highest in age group 1^+ and 2^+, it might be due to the fish eat as much as possible to attain the energy in order to recover their losses after spawning followed by a normal growth (Zakaria *et al*., 2000) [9]. Gupta *et al*., (2005) [11] reported in their studies on *Tor putitora* that the higher exponential values can be possible because of the comparatively higher Gastro somatic index (GSI) and growth of the gonads resulting in consequent increase in their body weights (their observed weights are higher than cube of their length).

Allen (1938) suggested that for ideal fish following 'cube law' the value of 'b' remains constant at '3'. But Hile (1936) and Martin (1949) illustrated that the value of 'b' usually ranges between 2.5- 4.0 and in majority of cases 'b' is not equal to '3'. The value of b <3 represents that the fish becomes less rotund as length increases and value of 'b' > 3 represents that the fish becomes more rotund as fish length increases. However, as per Wooton (1990) [2] the value for 'b' remains constant at 3 for the ideal fish, lesser or greater value indicate allometric growth either positive (b>3) or negative allometric growth (b<3). Various authors reported different values of exponent 'b' like Johal & Tandon (1981) [8] reported in *Tor putitora* (b= 3.38), Gupta *et al.*, (2005) [11] in *Tor putitora* (b= 3.68 in mature and 1.41 in immature), Gandotra *et al*. (2009) [13] in *Aspidoparia morar* (b= 1.43,2.86,2.94 and 3.07 in 0^+, 1^+, 2^+, 3^+ age groups respectively).

The slopes (b) of the L-W regression lines for *Labeo dero* was observed to fall within the range prescribed by above authors. It is evident from the present findings that although there are variations in the value 'b' in different age groups, yet the value remain close to '3' in all the cases thus, depicting the applicability of 'cube law' in the former cases. This proves that the fish grows isometrically in all stages of its life.

Isometric growth has been reported by a number of workers in different fish species viz. Nautiyal (1985) [24], Dasgupta (1991) [25], Tandon *et al*., (1993) [26], Zakaria *et al*., (2000) [9]; Gupta *et al*., (2005) [11]; Gandotra *et al*., (2008) [12]; Malviye *et al.* (2007) [27], Gandotra *et al*., (2009) [13]; Kanwal & Pathani (2011) [14]; Pawar *et al*., (2017) [17]. However, Gandotra *et al*., (2008) [12] reported allometric growth in 0+ age group but isometric in advanced age groups in *Tor putitora* from Jhajjar, Jammu.

Condition Factor

In the field of fisheries, the condition factor (K) is used in order to compare the condition, fitness or wellbeing of fish. The condition factor is important in understanding the life cycle of fish species, thus contributing to the management of the species and maintaining the equilibrium in the ecosystem (Kumolu-Johnson, 2010) [28]. Condition factor (K) is also a useful index for monitoring of feeding intensity, age and growth rates of fish (Anene, 2005) [29]. It is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of the aquatic ecosystem in which fish lives (Barnham, 1988) [30].

In the present studies, the value of (K) showed continuously declining i.e. 1.2268, 1.1015, 1.1008 and 1.0343 in 0^+, 1^+, 2^+ and 3^+ age groups respectively (Table: 1). The nearness of (K) value to 1.0 clearly indicates the suitability of the environment for fish growth. The present findings are in conformity with Gandotra *et al*., (2008); Gandotra *et al*., (2009) [12, 13].

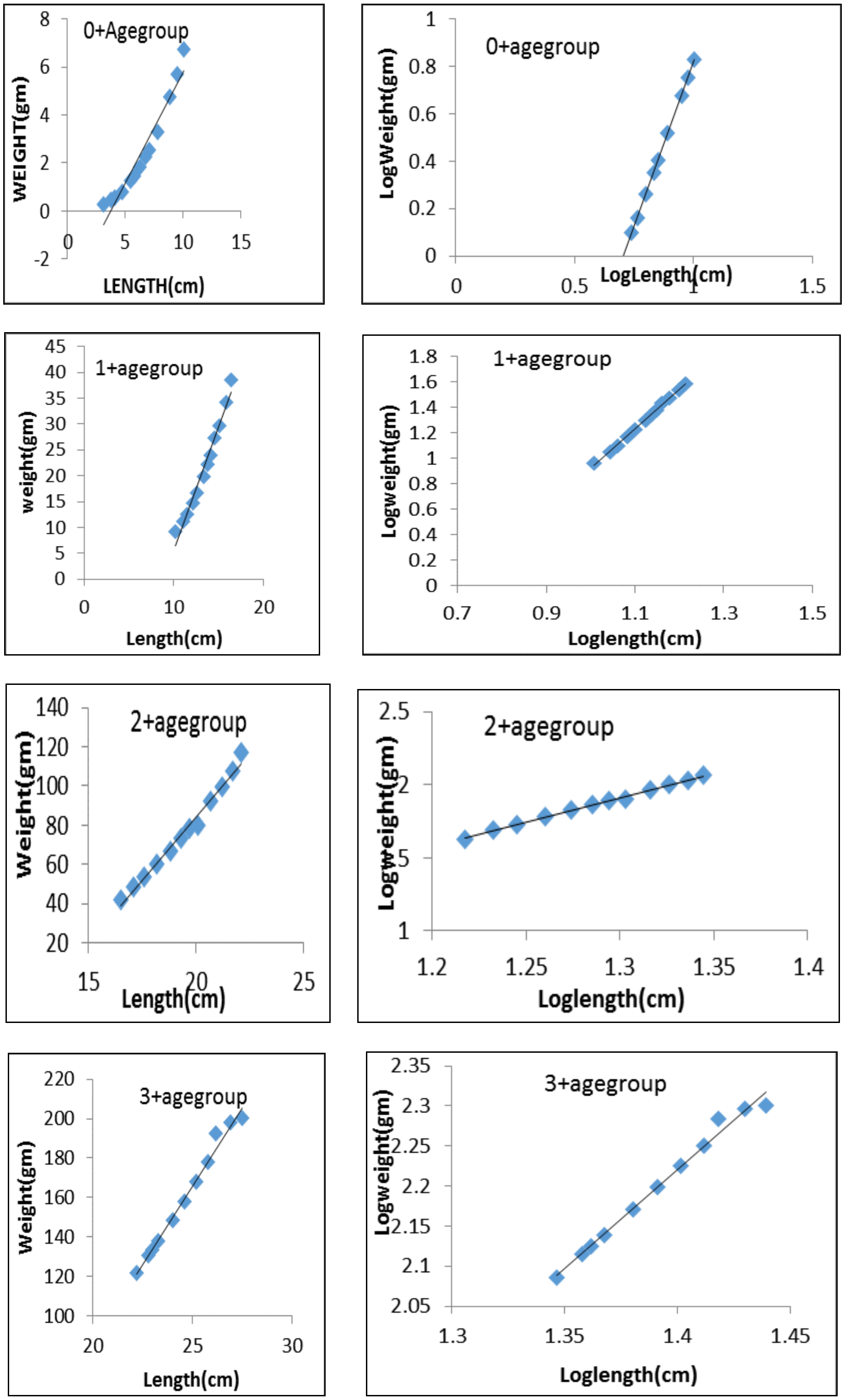
Further, the decreasing trend in the value of (K) value with advancing age show that there is less weight gain in comparision to the cube of length. The declining value of K with increase in length has also been reported by MacGregor (1959) [31]; Johal & Tandon (1981) [8], Zakaria *et al*., (2000) [9]; Olurin (2002) [10]; Gupta (2005) [11]; Kanwal & Pathani (2011) [14], Pawar *et al.*, (2017) [17].

Table 1: Length range of different age groups of *Labeo dero* along with the Condition factor in each group.

S. No.	Age group	Length range in cm			Condition factor (K)
		Min.	Mean	Max.	
1	0^+	3.1	6.75±3.51	10.1	1.2268
2	1^+	10.2	13.35±3.15	16.5	1.1015
3	2^+	16.6	19.35±2.75	21.1	1.1008
4	3^+	21.2	24.85±2.65	27.5	1.0343

Table 2: The value of 'b', 'r', parabolic equations and Logarithmic equation for length weight relationship in different age groups of *Labeo dero*

Age group	Value of regression coefficient (b)	Value of correlation coefficient(r)	Parabolic equation $W= aL^b$	Logarithmic equation LogW=Log a+ b LogL
0^+	2.756	0.978	$0.01148L^{2.756}$	LogW= -1.940 + 2.756 LogL
1^+	3.149	0.999	$0.00575L^{3.149}$	LogW= -2.240 + 3.149 LogL
2^+	3.319	0.995	$0.00395L^{3.319}$	LogW= -2.403 + 3.319 LogL
3^+	2.521	0.983	$0.04920L^{2.521}$	LogW= -1.308 + 2.521 LogL
Pool data	3.170	0.995	$0.00586L^{3.170}$	LogW= -2.232 + 3.170 LogL



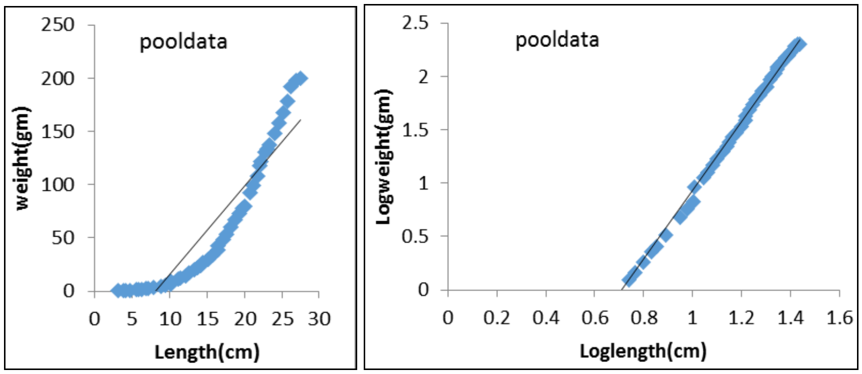


Fig 1: Parabolic and Logarithmic relationship between length and weight.

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