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Studies on length-weight relationship of *Mugil cephalus* (Linnaeus, 1758), (Family: Mugilidae) Chennai coast of Tamil Nadu

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Abstract
Length-Weight relationship was studied in *Mugil cephalus* collected from Kovalam, Southeast coast of India. The slope value (b) estimated for *Mugil cephalus* of both sexes was found to be 1.0368. The regression equations calculated for female was Log W = -0.7292 + 1.0368 Log L. The correlations coefficient was found to be significant (P<0.01). The significant difference between sexes of the species 'F' value was at 1% level. The slope value was compared here could be very useful for comparison with the brackishwater species in other geographical locations.

Keywords: Mugil cephalus, length-weight relationship, regression analysis, Population dynamics, Southeast coast of India

1. Introduction
Fishes of the family Mugilidae are commonly known as "mullets" or "grey mullets". This family includes 18 genera and 81 species [5, 22]. Commonly these fishes are found in marine and brackish waters or estuaries at 20 m depth. They are successful teleost fishes which make up an important and probably the most widely distributed commercial fishes in the coastal waters of tropical and subtropical regions of the world [26, 16, 21]. Fishes growth is isometric (i.e. a constant specific gravity) when the length exponent is 3 and allometric (growth with changing specific gravity) when the length exponent is greater or less than 3 [5]. Many researchers have published their reports on length-weight relationship (LWRs), condition factor (K) and relative condition factor (Kn) of the mugilid species such as, Length-weight relationship (LWRs) data of two mullet species, i.e., *Liza macrolepis* and *Mugil cephalus* from the different regions of world such as, near the coast of Mandapam (India), Negombo lagoon (Sri Lanka), Bonny estuary (Nigeria) and southwestern coast of Taiwan [19, 27, 2, 10].
First, it establishes the mathematical relationship between the two variables, length and weight so that the unknown variable can be readily calculated from the known variables in practical fisheries problem. Secondly, the relative condition can be estimated to assess the general wellbeing of the animals. Finally, it is used in the estimation of potential yield per recruit in the study of their population dynamics. The actual relationship between length and weight may part from the cubic value 3 and this may be due to environmental condition in which the animal lives and also due to the physiological condition of the animal. The estimation of yield per recruit in prediction models, and in the estimation of biomass from length observations and limited studies has been made on population dynamics. As no work has been done on this species thereafter from Chennai coast of Tamil Nadu, in the present study, an attempt has been made to study the length-weight relationship of *Mugil cephalus.*

2. Materials and Methods
2.1 Samples collection
A total of 166 specimens of *Mugil cephalus* were collected monthly from the landings at Kovalam fishing landing centre, during the period of September 2015 to February 2016. Total length (TL) of each specimen was measured in centimeters from the tip of snout to the end of caudal fin using measuring board. Weight (W) for each fish sample was noted on digital balance. Then fishes were immediately preserved in 10% formaldehyde solution for about one week, and after that stored in 70% ethanol for long time preservation.

They were kept in 10% formalin and sorted out into the various species in the laboratory using identification keys [25]. The total length (TL) and standard length (SL) of individuals of the different species of fish were measured to the nearest 1.0 cm, and the weight determined to the nearest 0.1 g using a measuring board and Sartorius balance, respectively. The parameters *a* (intercept) and *b* (slope) of the length-weight relationship of the form $W = aL^b$ were estimated for the different species through logarithmic transformation, i.e. log W = log a + b log L, with *a* and *b* estimated by ordinary least squares regression.

The Kovalam coast of Chennai backwaters is located between latitude (12° 48' 48.63" N 80° 14' 47.39'E) (Figure 1) that has an average annual rainfall of between, Tamil Nadu and Puducherry 44 cm of rainfall during the North East Monsoon. During in the month of October – December 2015 rainfall was recorded in 68 cm, which is 53% more. Kanchipuram district registered the heaviest rainfall 183% higher at 181.5 cm as against average rainfall of 64 cm in October-December period. Tiruvallur district recorded 146 cm when compared to average 59 cm of rain while Chennai, which is normally, receives 79 cm of rainfall, recorded 160 cm, 104% above average [4]. (Anon).

Fig 1: Location of Kovalam coast of Chennai backwaters

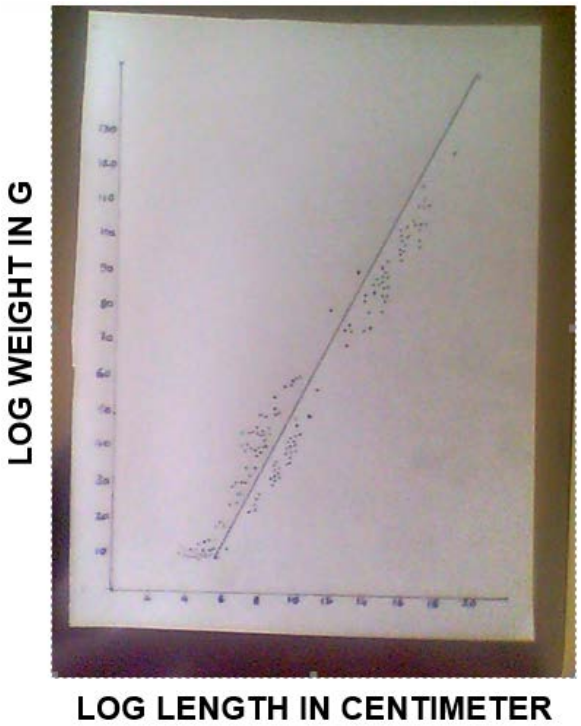

Fig 2: Logarithmic relationship between length and weight of males and females *Mugil cephalus* (Linnaeus, 1758).

3. Results

The maximum size the striped mullet grow to lengths up to 20.5 cm with weights as high as 90.0 gm. The linear equation was also fitted separately for both sexes. The correlation coefficient derived for the length-weight relationship for both sexes are given in Table.1. The regression equations derived for both the sexes are presented below Table.2.

$$\text{Log } W = -0.7292 + 1.0368 \text{ Log } L$$

The results showed significant of the both sexes of the species and the 'F' values were found to be significant at 1% level (Table.3). The correlations coefficient was found to be significant (P<0.01). The observed total length plotted against total weight for both sexes are presented in (Figure 2).

Growth of fish can be described as either allometric or isometric depending on the exponent *b* (regression coefficient) of the length-weight relationship which is normally between 2.0 and 4.0. The calculated slope value was 1.04 for both sexes. The log transform data of length-weight relationship (LWRs) was analyzed by the cube law to check whether the growth was positive or negative allometric, as shown in Table 1, 2 and 3. In general, the b-values reported for the combined sexes of all two mullet species ranged from 2.65 for *V. speigleri* to 3.59 for *L. macrolepis* [28, 15]. However, all regression coefficients (b) calculated in the present study for this mullet species lies within the expected range (2.5-4.0), therefore, suggesting that the result of length-weight relationship of this study was valid.

Table 1: Statistics in the length-weight relationship of males and females of *Mugil cephalus* (Linnaeus, 1758)

Sex	N	SX	SY	SX^2	SY^2	SXY
Both Sexes	166	343.2061	234.7815	716.3682	350.597	491.9585

N= Number of fish

SX^2, SY^2, SXY = Sum of squares and product

SX, SY = Sum of logarithmic values of length and weight respectively.

Table 2: Regression data for the length-weight relationship of males and females of *Mugil cephalus* (Linnaeus, 1758)

Sex	Sum of Squares and Products				
	X^2	XY	Y^2	b	DF
Both Sexes	716.3682	491.9585	350.597	1.0368	165

DF: Regression freedom

B: Regression Co-efficient

SS: Sum of Squares

Table 3: Test of Significance

Source of Variation	DF	Sum of Square	Mean Square	Observed F
Deviation from individual with in sexes	1	1066.965	1066.965	164.9988
Difference between Regression	165	1066.965	6.4665	
Deviation from Total Regression	166	2133.93		Significant at 1% level

4. Discussion

It is universal that growth of fishes or any other animal increases with the increase in body length. Thus, it can be said that length and growth are interrelated. Length weight relationship is expressed by the cube formula $W = aL^3$ by earlier workers [8, 9, 18]. The present study, the slope value (b) estimated for *M. cephalus* of both sexes was found to be 1.04. The regression equations calculated for female was Log W = -0.7292 + 1.0368 Log L. The significant difference between sexes of the species 'F' value was at 1% level. In majority of the fishes the shape and density change with increasing age, which often causes the regression coefficient of weight of length, depart from 3. The studied was revealed that the length-weight relationship of grey mullet *M. cephalus* from Hooghly – Matlah estuary and gave the regression value as 2.8779 [14, 23] has been studied the length-weight relationship of *M. cephalus* from Pulicat lake and reported the regression value as 2.9128.

In fishes, generally the growth pattern follows the cube law [18]. Beverton and Holt (1957) stated that major deviations from isometric growth are rare. Such cubic relationship for fishes will be valid when fish grows isometrically. But in reality, the actual relationship between the variables, length and weight, may depart from this, either due to environmental conditions or condition of fish [17]. According to Martin (1949) the value of the exponent 'b' in the parabolic equations usually lies between 2.5 and 4. Depending upon the deviation of 'b' values from '3' fishes can be classified into three groups (i) b= 3 where the body form of fish remains constant at different lengths (isometric) [4], (ii) b<3 when fish becomes more slender as the length increases and (iii) b>3 (allometric) when fish grows more stouter with increase of length [12]. In majority of the fishes the shape and density change with increasing age, which often causes the regression coefficient of weight of length, depart from 3. The present observation is also in agreement with the above view and it can be concluded that the cube formula $W = al^3$ will not be a proper representation of the length-weight relationship for *M. cephalus* as the 't' value is significantly different and the growth is not isometric.

Beverton and Holt (1975) suggest that the value of 'n' is almost always near to 3. Several theories have been advance by a number of workers as to what governs or influences the value of 'n' is dependent and governed by the feeding behavior of fish. Also the size of type of food consumed by the fish seems to have influence on the value of 'n' for example, planktonivores, herbivores and predators have different ranges for the value of 'n' *M. cephalus* are undergoing progressive charges in shape and condition as they grow and consequently affecting the regression of the log of weight and log of length.

In fishes 'b' value is usually '3' in the length-weight relationship, but during growth change in specific gravity of body contour, morphological changes due to age may also cause the coefficient of regression of logarithm on logarithm of length, to depart substantially from 3.0 [24]. Thus, comparing the slope of *M. cephalus* with other brackishwater species, it could be concluded that the slope value is less than 3 for the both sexes of *M. cephalus*.

5. Conclusion

In fishes 'b' value is usually '3' in the length-weight relationship, but during growth change in specific gravity of body contour, morphological changes due to age may also cause the coefficient of regression of logarithm on logarithm of length, to depart substantially from 3.0 [24]. Deviation in the

growth rate 'b' observed during the present investigation may be the result of variations in ecology of the geographical locations or due to changes in the environmental conditions [2]. The parameter b, unlike the parameter a, may vary seasonally, and even daily, and between habitats. Thus, the length-weight relationship is affected by a number of factors including gonad maturity, sex, diet, stomach fullness, health, and preservation techniques as well as season and habitat. Others include seasonal variability of the environment and food availability [13], sample size and the length interval within different areas [11]. The LWR parameters may also vary within the same species due to feeding, reproduction and fishing activities [6], environmental changes, individual metabolism, sexual maturity and age [16]. Thus, comparing the slope of *M. cephalus* with other Mugilidae species, it could be concluded that the slope value is less than 3 for the both sexes of *M. cephalus*.

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