

Length-weight and width-weight relationship of freshwater crabs *Oziotelphusa bouvieri* and *Spiralothelphusa wuellerstorfi* (Family: Gecarcinucidae) of Puzhal lake, Chennai, Tamil Nadu

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ABSTRACT

Length-weight analysis helps in determining the stock of the habitat where species inhabit. The main objective of this present study is to determine the stock by studying the length-weight and width-weight relationship of collected species from the research area. In order to determine the values statistically, Student's t-test, degree of correlation and Fulton condition factor were calculated. In the current study, Correlation values are more or less close to unity, indicating a high degree of positive correlation with length/width against weight. t_b and p value for both species were also determined, indicating highly significant p values ($p < 0.05$). Fulton's condition factor values were also determined for both male and female crabs of both species. Estimation of the size-weight relationship helps in determining the stock and is the major criterion in influencing the study involved in biology, ecology and maturation of finfishes as well as crustaceans.

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1. Introduction

Stock assessment is one of the important methods in estimating the population of aquatic organisms in a destined location. Length-Weight and Width-Weight relationship are major factors in calculating the stock of organisms such as fishes, crustaceans, etc. and the population of different stocks of the same species could also be determined (Vidhya *et al.*, 2018). The size-weight relationship seems to be the major criterion in studying biology, ecology and maturation of finfishes and crustaceans. Apart from determining this relationship, estimating condition factors helps in comparing the well-being of organisms. These factors differ for several reasons, such as growth and feeding rate, environmental conditions, etc. (Noori *et al.*, 2015) for the same species in different geographic locations. Condition factors help understand the basic pattern of actual growth and also help in estimating the factors for decreasing or increasing growth statistically. In such conditions, Fulton condition factor becomes an effective method in estimating the actual condition of species in that habitat.

There has been significant work carried out on the Length/Width- Weight relationship of various finfishes and commercially important marine crabs (Atar and Secer, 2003; Khristenko and Kotovska, 2016; Arshad *et al.*, 2006; Thirunavukkarasu and Shanmugam 2011; Jin *et al.*, 2015). Length/ Width- Weight relationship of freshwater crabs is so fragmentary, especially on highly diverse crab species of the family Gecarcinucidae. *Oziotelphusa bouvieri* and *Spiralothelphusa wuellerstorfi* are highly diverse species found throughout the peninsular region of India, but proper research is needed on the ecological, morphometric and stock assessment of these species (Cumberlidge *et al.*, 2009). The present study aimed to evaluate the length/ width- weight relationship of *Oziotelphusa bouvieri* and *Spiralothelphusa wuellerstorfi* and determine Fulton's condition factor for these species.

2. Materials and Methods

Live specimens of Freshwater crabs *Oziotelphusa bouvieri* and *Spiralothelphusa wuellerstorfi* were caught from Puzhal lake, Chennai. The Carapace Length (CL) and Carapace Width (CW) of these crabs were measured using Vernier Calliper (in mm) and weighed to the nearest gram in the electronic weighing machine. About 214 crabs (102 male and 112 female) of the species *Oziotelphusa bouvieri* and 210 (104 male and 106 female) of the species *Spiralothelphusa wuellerstorfi* were collected and measured. Matured adult crabs for both the species were chosen for the study. Length/Width-Weight relationship of male and female for both species was determined by using the equation $W=aL^b$ where W is weight of the crab and L determines the Length/Width of the crab. 'a' and 'b' are the constants. As per *Le Cren* (1951) methodology, equation was converted to logarithmic forms $\text{Log } W = \text{Log } a + b \text{ Log } L$. Log a and Log b were evaluated empirically using linear regression method. The standard error for the slope 'b' was also determined. Student's t-test was used to test the isometric growth hypothesis. The t-test equation (to determine slope and intercept) $t_b = (b-3)/S_b$ (Sokal and Rohlf, 1987) (t_b refers to t-test value of slope b, b is slope value and S_b is standard error of slope b) was used to determine the significance of the hypothesis.

The degree of the coefficient was also determined by determining r value through the regression method. Maximum, Minimum and Mean values of Fulton's Condition factor were determined using the equation $K=100(W/L^3)$ (Bagenal and Tesch, 1978) where K is the condition factor, W is the Weight of the crab, L is the Length/Width of the crab.

3. Results

The Scatter diagram was used to plot the Logarithmic values of Length-weight and Width-weight and obtained linear equations for both species. 'b' value for *Oziotelphusa bouvieri* male and female were 2.04 and 2.38, respectively for the

length-weight relationship and 2.05 and 1.27 respectively for Width-weight relationship. For *Spiralothelphusa wuellerstorfi* 'b' values length-weight relationship was 1.76 and 2.47 for male and female and 1.87 and 2.20 for male and female for the width-weight relationship, respectively. These results indicated that the growth represents negative allometry for both the crab species as b is lesser than 3. Logarithmic equations for both species are indicated (Table 1 & 2). Coefficient of correlation (r) value was determined 0.834 and 0.912 for male and female crabs of *Spiralothelphusa wuellerstorfi* and 0.963 and 0.957 for male and female crabs of *Oziotelphusa bouvieri* for Length-

Weight relationship whereas for Width-weight relationship the values are 0.871 and 0.934 for male and female crabs of *Spiralothelphusa wuellerstorfi* and 0.8871 and 0.787 for male and female crabs of *Oziotelphusa bouvieri* (Fig 1-8) (Table 3-10).

These values are more or less close to unity, and it indicates that a high degree of positive correlation exists between length/width and weight. t_b and P value for both the species were also determined and it indicated highly significant P values ($p < 0.05$). Fulton's condition factor values were also determined for both male and female crabs of both species.

Table 1. Logarithmic equation for Carapace Length-weight relationship

| <i>O. bouvieri</i> | | <i>S. wuellerstorfi</i> | |
|-------------------------------|------------------------------|-------------------------------|------------------------------|
| Male | Female | Male | Female |
| Log W= -1.7487+2.0479 (0.897) | LogW= -2.2637+2.3836 (1.432) | Log W= -1.4583+1.7656 (0.964) | Log W= -2.437+2.4719 (1.723) |

Table 2. Logarithmic equation for Carapace Width-weight relationship

| <i>O. bouvieri</i> | | <i>S. wuellerstorfi</i> | |
|-------------------------------|------------------------------|-------------------------------|-------------------------------|
| Male | Female | Male | Female |
| Log W= -1.9666+2.0531 (0.673) | LogW= -0.7178+1.2727 (0.834) | Log W= -1.7668+1.8728 (0.624) | Log W= -2.2535+2.2045 (1.294) |

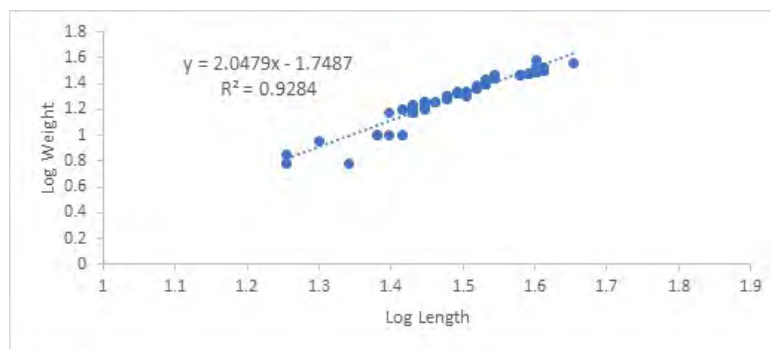


Fig. 1. Logarithmic Length-Weight relationship of *Oziotelphusa bouvieri* (Male)

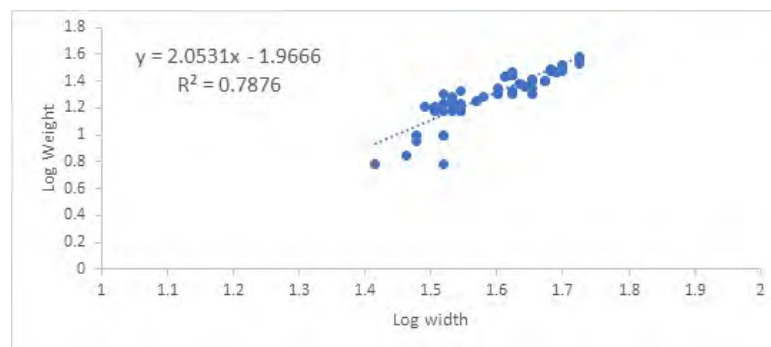


Fig. 2. Logarithmic Width-Weight relationship of *Oziotelphusa bouvieri* (Male)

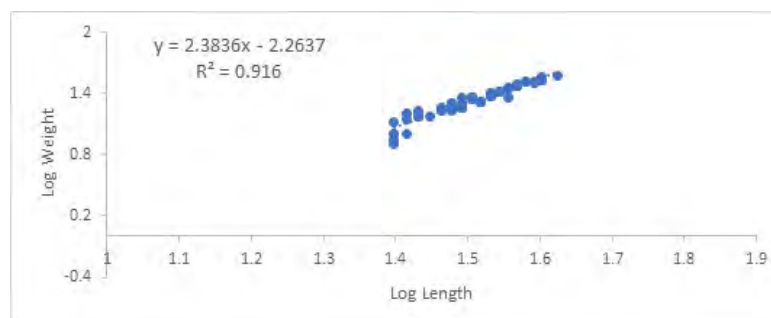


Fig. 3. Logarithmic Length-Weight relationship of *Oziotelphusa bouvieri* (Female)

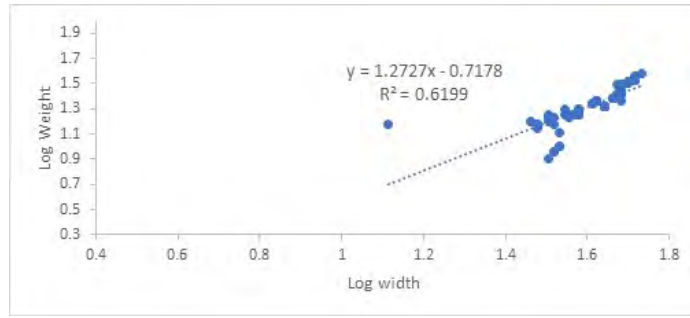


Fig. 4. Logarithmic Width-weight relationship of *Oziothelphusa bouvieri* (Female)

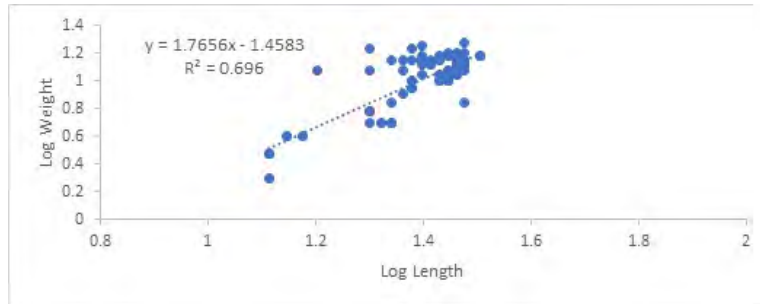


Fig. 5. Logarithmic Length-Weight relationship of *Spiralothelphusa wuellerstorfi* (Male)

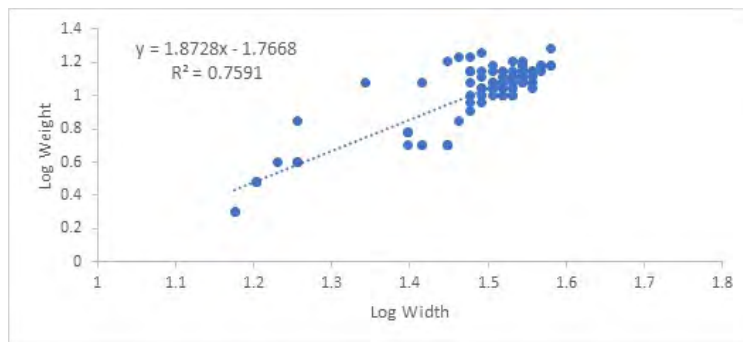


Fig. 6. Logarithmic Width-weight relationship of *Spiralothelphusa wuellerstorfi* (Male)

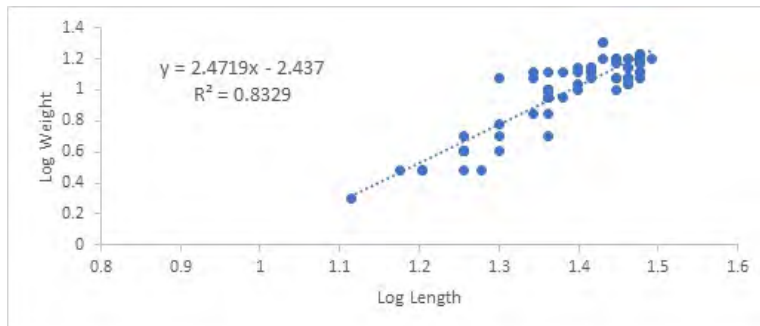


Fig. 7. Logarithmic Length-Weight relationship of *Spiralothelphusa wuellerstorfi* (Female)

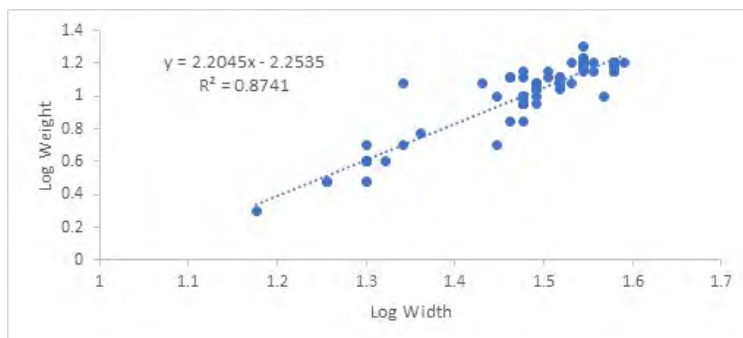


Fig. 8. Logarithmic width-weight relationship of *Spiralothelphusa wuellerstorfi* (Female)

Table 3. Parameters of length-weight relationship for *S. wuellerstorfi*

| Sex | a | b | r | S _b | t _b | P |
|--------|---------|--------|-------|----------------|----------------|-------------------------|
| Male | -1.4583 | 1.7656 | 0.834 | 0.115 | -10.68 | 1.259×10 ⁻¹⁸ |
| Female | -2.437 | 2.4719 | 0.912 | 0.1085 | -4.86 | 2.04×10 ⁻⁶ |

Table 4. Parameters of length-weight relationship for *O. bouvieri*

| Sex | a | b | r | S _b | t _b | P |
|--------|---------|--------|-------|----------------|----------------|------------------------|
| Male | -1.7487 | 2.0479 | 0.936 | 0.056 | -16.74 | 4.53×10 ⁻³¹ |
| Female | -2.2637 | 2.3836 | 0.957 | 0.068 | -8.954 | 4.83×10 ⁻¹⁵ |

Table 5. Parameters of Width-weight relationship for *S. wuellerstorfi*

| Sex | a | b | r | S _b | t _b | P |
|--------|---------|--------|-------|----------------|----------------|------------------------|
| Male | -1.7668 | 1.8728 | 0.871 | 0.1044 | -10.789 | 7.30×10 ⁻¹⁹ |
| Female | -2.2535 | 2.2045 | 0.934 | 0.082 | -9.698 | 1.58×10 ⁻¹⁶ |

Table 6. Parameters of Width-weight relationship for *O. bouvieri*

| Sex | a | b | r | S _b | t _b | P |
|--------|---------|--------|-------|----------------|----------------|------------------------|
| Male | -1.9666 | 2.0531 | 0.887 | 0.1066 | -8.880 | 1.39×10 ⁻¹⁴ |
| Female | -0.7178 | 1.2727 | 0.787 | 0.095 | -18.179 | 3.15×10 ⁻³⁵ |

4. Discussion

In this current study, 'b' value for male and female of both species were below 3 which indicates negative or hypo allometry. Similar results were obtained by studying length-weight relationship of freshwater crab *Sudanonautes africanus* which showed negative allometry for male and entire population but positive allometric growth among female crabs (Olusoji *et al.*, 2010). Analysis of length-weight or width-weight relationships of various crabs varied according to environmental condition, geographic condition, feeding habits etc. Considering marine crab *Scylla paramamosain*, 'b' values observed were 3.23 for male, 2.59 for female and 2.71 for entire population which indicates that female and the entire population exhibited negative allometry except for male (Suryandari *et al.*, 2002). In shore crab *Pachygrapsus transversus* allometric relation of carapace width and carapace length of male and female showed negative allometric growth (Flores and Fransozo, 1999). In freshwater crabs *Barythelphusa guerini*, observed b values were less than 3, showing negative allometric growth (Patil and Patil, 2012). Similarly, in *S. tranquebarica*, observed b values were nearly 3 and exhibited positive allometric growth (Thirunavukkarasu and Shanmugam, 2011). In *Parluciosoma daniconius*, the observed b value was less than 3, similar to the current study (Sanjay *et al.*, 2016). Japanese mitten crab, *Eriocheir japonica* exhibited isometric growth and observed b value was 3 (Zhang *et al.*, 2017). Estuarine crab, *Callinectes* sp. exhibited negative allometric growth (Moslen and Miebaka, 2017). Whereas in marine crab, *Portunus pelagicus* observed b value was more than 3 and exhibited positive allometric growth (Rohmayani *et al.*, 2002); allometric growth of three marine crab species namely *L. depurator*, *L. navigator* and *E. verrucosa* expressed negative allometry and other two species, *P. marmoratus* and *C. aestuarii* expressed isometric growth (Aydin, 2018); isometric and negative allometric growth were observed among male and female *Ucides cordatus* (Pinheiro and Fiscarelli, 2009); Positive

Table 7. Fulton's condition factor (K) for Length-weight relationship of *S. wuellerstorfi*

| Sex | Max | Min | Mean |
|--------|--------|--------|--------|
| Male | 0.2929 | 0.0259 | 0.0727 |
| Female | 0.15 | 0.0410 | 0.0689 |

Table 8. Fulton's condition factor (K) for Length-weight relationship of *O. bouvieri*

| Sex | Max | Min | Mean |
|--------|--------|--------|--------|
| Male | 0.1200 | 0.0395 | 0.0681 |
| Female | 0.0910 | 0.0492 | 0.0642 |

Table 9. Fulton's condition factor (K) for width-weight relationship of *S. wuellerstorfi*

| Sex | Max | Min | Mean |
|--------|--------|--------|--------|
| Male | 0.1200 | 0.0227 | 0.0397 |
| Female | 0.1126 | 0.0197 | 0.0383 |

Table 10. Fulton's condition factor (K) for width-weight relationship of *O. bouvieri*

| Sex | Max | Min | Mean |
|--------|--------|--------|--------|
| Male | 0.0556 | 0.0166 | 0.0339 |
| Female | 0.6827 | 0.0207 | 0.0370 |

allometric growth in male and isometric growth in female marine crab *Portunus signis* (Noori *et al.*, 2015).

By analysing, Fulton condition factor, in this current study, it was ranging between 0.0359 and 0.1200 in male *O. bouvieri* for female it was from 0.0492 to 0.0910 for same species. In *S. wuellerstorfi* it ranged between 0.0259 and 0.2929 in male and 0.0410 to 0.15 in female. Current results were more compared to condition factors observed in male (0.000802) and in female (0.000669) freshwater crabs of *Barythelphusa guerini* (Patil and Patil, 2012). Condition factors observed in other marine crabs were namely 1.52 and 1.38 in male and female of *S. paramamosain* (Suryandari *et al.*, 2002); 1.099 to 1.086 in *Parluciosoma daniconius* (Sanjay *et al.*, 2016); 1.01-2.09 in estuarine crab *Callinectes* sp. (Moslen and Miebaka, 2017); 5.04 to 8.88 in male, 4.22 to 11.70 in female crab *Portunus pelagicus* (Rohmayani *et al.*, 2002); 66.52 in male, -67.64 in female crab *Callinectes pallidus* (Oluwatoyin *et al.*, 2013); 48.196 and 6.638 in *Callinectes sapidus* (Atar and Secer, 2003).

Stock assessment studies like length/width weight relationship of *O. bouvieri* and *S. wuellerstorfi* were determined for the first time in India. Being highly diverse species, proper study on the population and condition of these species is very low. According to IUCN, these two species are categorized as data deficient species as there is no considerable work on population, ecology, stock assessment and future threats (Cumberlidge *et al.*, 2009). If this lack of data continues, then there could be possible conditions for a decline in the population of these species (Bland *et al.*, 2017). Therefore, this study provided considerable values in determining allometry and condition factors for these two species.

From the above results, the exponential b value for both species was less than 3. Statistically b value determines the slope of the logarithmic equation and for proper isometric growth of the crab it should be 3 (b=3) where length/width is independent of weight. If the value is greater than 3

($b > 3$), then it is said to exhibit positive allometric growth where length/width increases with an increase in weight. If b value is lesser than 3 ($b < 3$) then it is said to exhibit negative allometric growth where length/width decreases with an increase in weight. Therefore, both species of crabs exhibit negative allometric growth and are statistically highly significant ($P < 0.05$).

Unlike marine crab, these crabs exhibited negative allometry, indicating a lack of proper food for satisfying the growth. These results oblige with other freshwater crab *Barythelphusa guerini* which also exhibited negative allometry (Patil and Patil, 2012). The b value of *O. bouvieri* indicates that male is heavier than female in given width against weight and female is heavier in a given length against weight whereas in *S. wuellerstorfi* female is heavier than male in length and width against weight. Coefficient of correlation (r) is used to determine the correlation of carapace length/width with weight. From the above results,

r value was close to unity, indicating a high correlation with carapace length/width against weight.

Fulton's condition factor was higher in male of both species by analysing the length-weight relationship, whereas in width-weight relationship, condition factor was higher in female *O. bouvieri* but it was higher again in male with *S. wuellerstorfi*. This higher value of condition factor could be due to over gonadal development observed in female *O. bouvieri*. Fulton's condition factor (K) is used to determine the growth and sex composition of organisms in appropriate climatic condition. In this study, the mean values of male are higher than female in length-weight relationship of both the species, whereas in the width-weight relationship, the mean value is higher in females than male. This difference is due to effect of various environmental conditions, growth, availability of food and foraging behavior (Patil and Patil *et al.*, 2012; Khristenko and Kotovska 2017).

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