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Length- Weight Relationship of a Precambrian Benthic Brachiopod Species- *Lingula Anatina* (Lamarck, 1801) Inhabitant in Subarnarekha Estuarian- Mangrove Ecotone, India

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Abstract: *Studies were conducted for two consecutive years on length- weight relationship of Lingula anatina from an ecotone, at the confluence of Subarnarekha estuary with Bay of Bengal, at the junction of West Bengal- Orissa coast, India (21°35'48" Northern Latitude and 87°27'17" Eastern Longitude). The relationship was determined by the formula $W= a\ L^b$ and condition factor (K_n) was calculated by the equation $K= (w\times10^5)/(L)^3$. The 'b' value has been found to be lower than 1 indicating negative allometric pattern of growth and lower kn value as recorded at all study sites indicate their unsuccessful settlement. Insignificant results of Statistical analysis further established that length had no significant effect on growth of studied species.*

Keywords: *Lingula anatina, Length- weight relationship, condition factor, Subarnarekha estuary.*

1. INTRODUCTION

Mangrove ecosystem, a unique, fragile, highly productive ecosystem in the sea- land interphase, is the conglomerations of plants, animals and microorganisms acclimatized in the fluctuating environment of tropical intertidal zone. [1 and 2]. The intertidal belt of Midnapore coast, especially the studied area (Longitude 87º5′ E to 88º5′ E and latitude 20º30′ N to 22º2′ N) supports diversified forms of macrobenthic fauna which include good number of inarticulate brachiopodans-*Lingula anatina* [3]. The studied animals are found in three different morphotypic form at three contrasting intertidal mudflats at Midnapore (East) - Balasore coastal region. Morphometric analysis serves as a handy tool for both taxonomists and ecologists investigating on intra and interspecific morphological variations [4]. Abrupt variations in body proportions are noticed in body weight versus length relationships in a population is of great importance for estimating the population size, general ecological growth modeling and energy flow within ecosystems [5]. The relationship between body mass and length is an effective tool in ecological research in order to estimate body mass from the body length of an organism, as when the direct measurement of dry mass is problematic under natural settings. The length-weight relationships study assumes an important prerequisite in fishery biological investigations. Such method appears to through deal with to know the light on the growth potential of benthic animal where in expected weight from the known length groups. Findings also provide information on fatness, breeding and feeding state and their suitability to the environment. The study is also perceived to establish precise mathematical equations between the length and w eight. So that if one of the two parameters is measured the other could be computed. There have been so many investigations on length-weight relationship mainly of fishes. Some other works on this topic have already been published by various authors in West Bengal on benthic estuarine macrofauna. [6, 7, 8 and 9]. However no such studies have been conducted previously to determine the length- weighty relationship of *Lingula anatina* from present study sites. The present study has aimed at establishing base line information on the length- weight relationship of studied species at the confluence of Subarnarekha estuary.

2. MATERIALS AND METHODS

The study was conducted on *Lingula anatina* for two consecutive years from June, 2009 to July, 2011 at three contrasting mudflats (Viz. S-I, S-II and S-III) near Talsari, Subarnarekha estuary (21°35'48" Northern Latitude and 87°27'17" Eastern Longitude) (Figure- 1). After random sampling by 1m^2 quadrate along three transects lying on different zones of intertidal belts lengths (cm) and weight (gm) were determined. Wet weight (gm) was estimated with the help of a digital balance (model no. D S 252, Essae- Teraoka Limited) and lengths (cm) were recorded with the help of slide calipers and with a plastic scale.

The length- weight relationship were estimated following the standard literature [5] and using the equation, w= a L^b , where w is total body weight (gm), L is total length (cm), a and b were estimated by the linear regression where 'a'= intercept of the regression curve, 'b'= regression coefficient (slope) and 'b' value represented as the relative growth constant. Parameter estimation was made through a logarithmic transformation of L- W data pairs. Analysis was done using the Q1Macros, 2014 software for regression and following Log W= Log a + b×Log L formula. According to [5] if 'b' = 1, the growth is isometric (length and weight increases proportionally); 'b' ›1, growth is positively allometric (weight increases faster than length) and 'b' ‹ 1, growth is negatively allometric (length increases faster than weight). The formula presently used for determination of length- weight relationship of *Lingula anatina*, and condition factor (K_n) were most typically used by fishery researchers earlier. The K_n was computed by the formula K= $(w\times10^5)/(L)^3$; where w= total weight of studied species in grams, L= total lengths in centimeters and 10^5= it has been introduced to bring the value of ponderal index near the unity[10].

3. RESULTS

Measurements of total mean length and total mean weight of individual *Lingula anatina*, correlation, regression and't-test' results between length with weight has been shown in Tables 1,2 and 3. As shown in Table-1, *L. anatina* having longest length of individuals were mainly found at S-I followed by S-III and S-II among all three study sites. The highest weight of *L. anatina* recorded during present study were 8.38 ± 0.75 of those individuals who were the inhabitants of at S-I followed by S-III and S-II. (Table-1). The correlation and't-test'(Tables-2 and 3) have revealed that there existed insignificant relationship between the length and weight of studied species. Documented results have expressed that the length (cm) and body weight (gm) of studied animal at all three study sites were almost constant throughout the study period (Figure-2 to7). The regression equation were expressed as Log w = 2.43-0.12 ×Log L, Log w = 3.18 -0.43 ×Log L, Log w = -1.26 + 0.11 ×Log L, Log w = - 1.05 + 0.03×Log L, Log w = -0.56 + 0.33 ×Log L, Log w = 0.66-0.16 ×Log L,

Table 1. *Length (cm) and weight (gm) relationship ($W=aL^b$) in Lingula anatina.*

Study site	TL	Lengths (cm) (Mean±SD)	Weight (gm) (Mean±SD)	a	b	r^2	P value
S-I	MTL	12.77±0.89 (10.7-14.4)	8.38±0.75 (7.14-9.61)	2.43	-0.12	0.01	0.64
	LTL	12.67±1.06 (10.6-14.2)	8.15±0.62 (6.97-9.34)	3.18	-0.43	0.22	0.02
S-II	MTL	7.90±0.80 (6.6-9.8)	0.35±0.03 (0.29-0.42)	-1.26	0.11	0.01	0.62
	LTL	8.17±0.81 (7.1-9.8)	0.37±0.05 (0.28-0.48)	-1.05	0.03	0.00	0.90

S-III	MTL	11.45±0.61 (10.2-12.6)	1.30±0.20 (0.94-1.64)	-0.56	0.33	0.01	0.60
	LTL	11.59±0.77 (10.5-13.7)	1.31±0.11 (1.08-1.57)	0.66	0.16	0.01	0.57

Table 2. *Correlation of coefficient matrix of length- weight relationship of L. anatina*

	S-I MTL LEN		S-I LTL LEN		S-II MTL LEN		S-II LTL LEN		S-III MTL LEN		S-III LTL LEN
S-I MTL WET	-0.07	S-I LTL WET	-0.47**	S-II MTL WET	0.11	S-II LTL WET	0.06	S-III MTL WET	0.07	S-III LTL WET	-0.11

***significant at 0.01 level.*

Table 3. *Result of't- test' (paired two samples) for means (α =0.01) of length and weight of L. anatina*

	Observations	df	't' stat	P(T<=t) two tail	T critical (two tail)	Remarks
S-I MTL L * S-I MTL W	24 months	23	0.022	0.98	2.807	Insignificant
S-I LTL L * S-I LTL W	24 months	23	0.021	0.98	2.807	Insignificant
S-II MTL L * S-II I MTL W	24 months	23	-0.005	0.99	2.807	Insignificant
S-II LTL L * S-II LTL W	24 months	23	-0.050	0.96	2.807	Insignificant
S-III MTL L * S-I II MTL W	24 months	23	-0.051	0.95	2.807	Insignificant
S-III MTL L *S-IIIMTL W	24 months	23	-0.015	0.988	2.807	Insignificant

Table 4. *Fluctuation of condition factor of L. anatina*

Study site	S-I MTL	S-I LTL	S-II MTL	S-II LTL	S-III MTL	S-III LTL
Condition factor	0.69	0.69	0.13	0.12	0.15	0.14

Abbreviations used

S-I: Study site-I; S-II: Study site-II; S-III: Study site-III; L: Length; W: Weight; MTL: Mid tide level; LTL: Low tide level

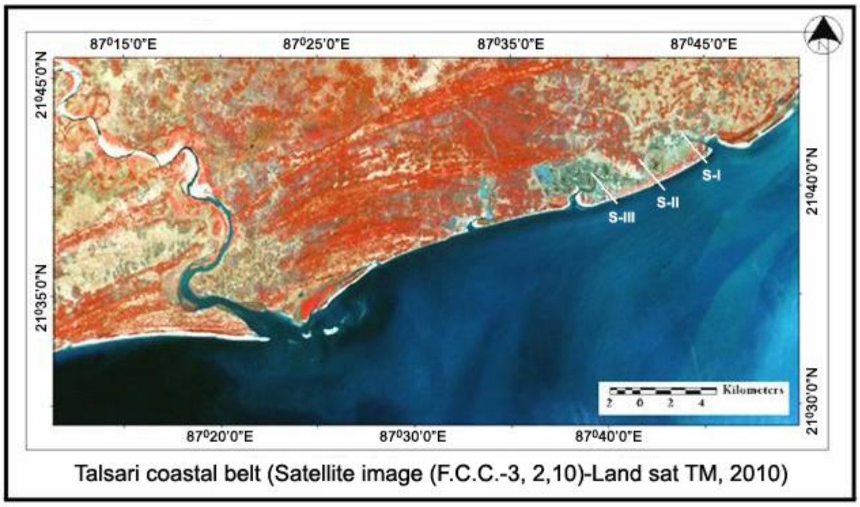

Figure 1. *Satellite image of study sites.*

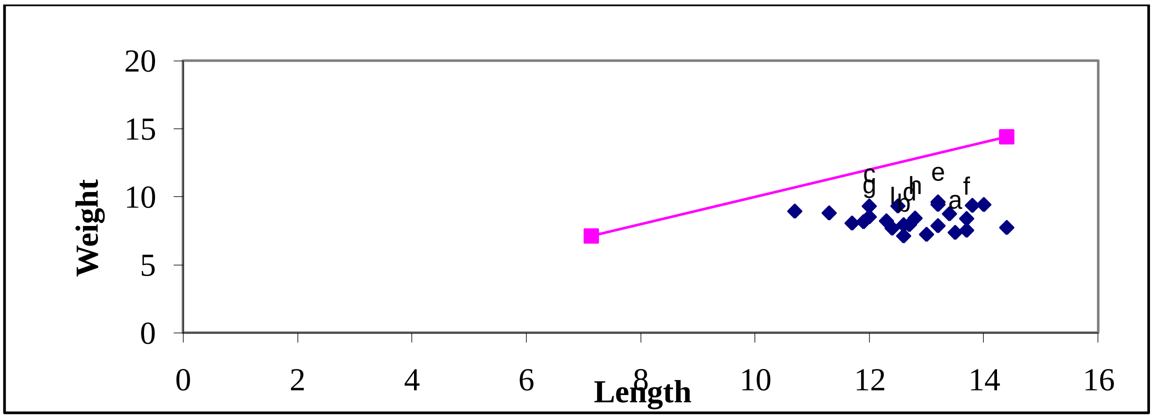

Figure-2. *Scatter plot of total length and body weight of Lingula anatina at S-I, MTL during study period.*

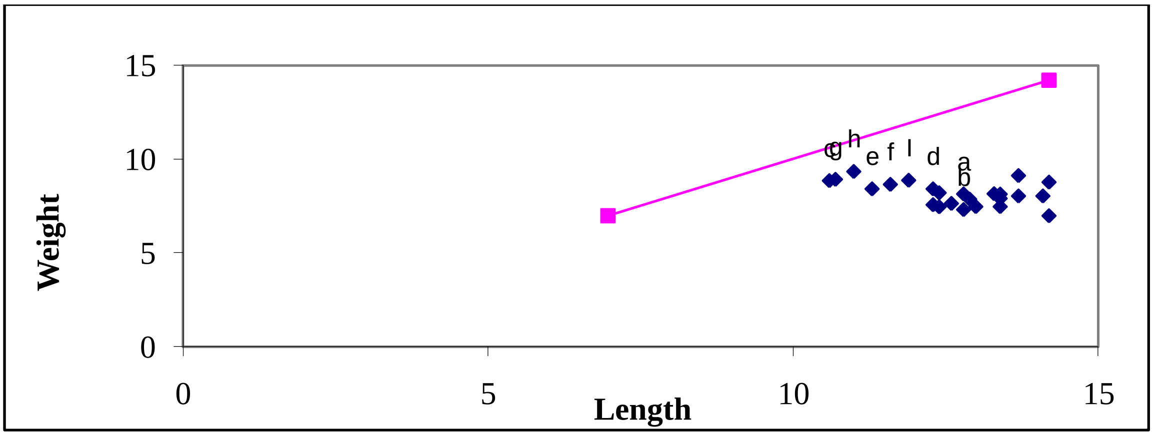

Figure-3. *Scatter plot of total length and body weight of Lingula anatina at S-I, LTL during study period*

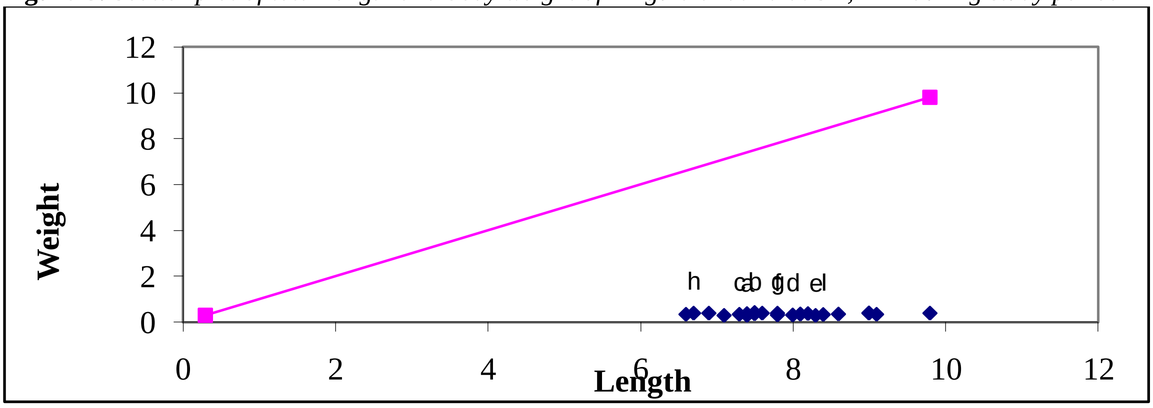

Figure-4. *Scatter plot of total length and body weight of Lingula anatina at S-II, MTL during study period.*

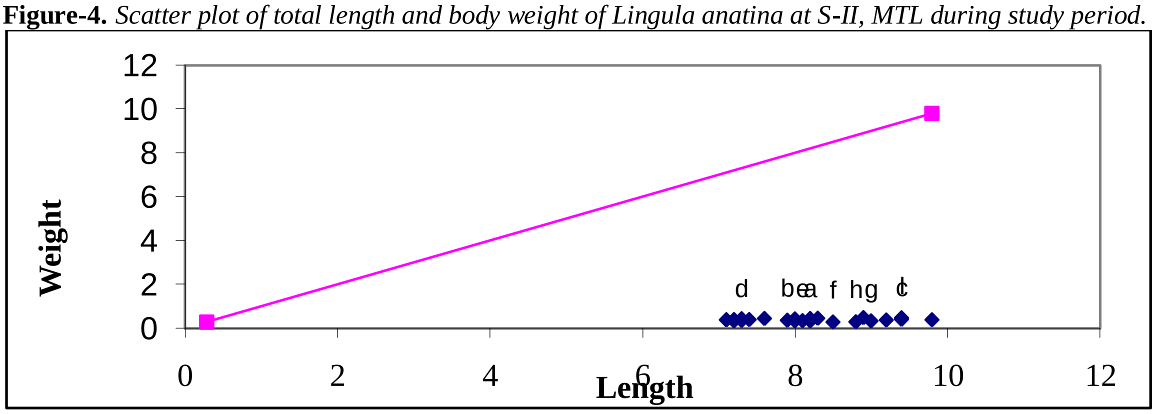

Figure-5. *Scatter plot of total length and body weight of Lingula anatina at S-II, LTL during study period.*

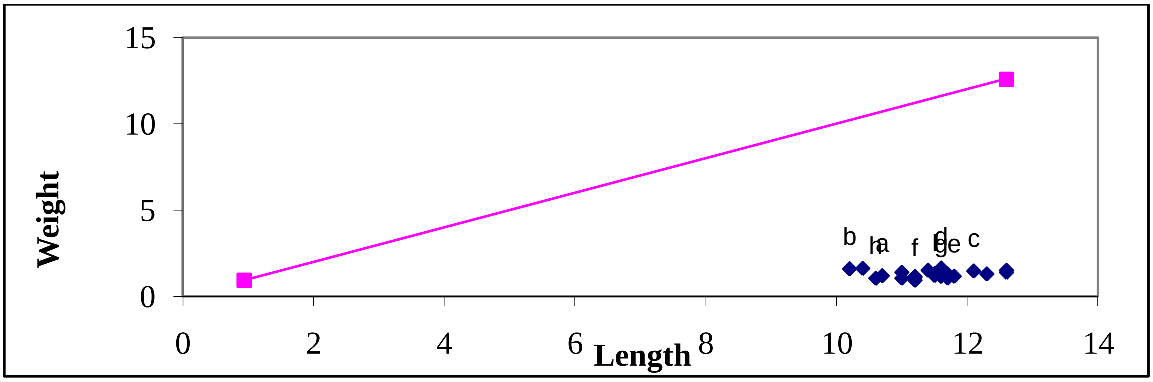

Figure-6. *Scatter plot of total length and body weight of Lingula anatina at S-III, MTL during study period.*

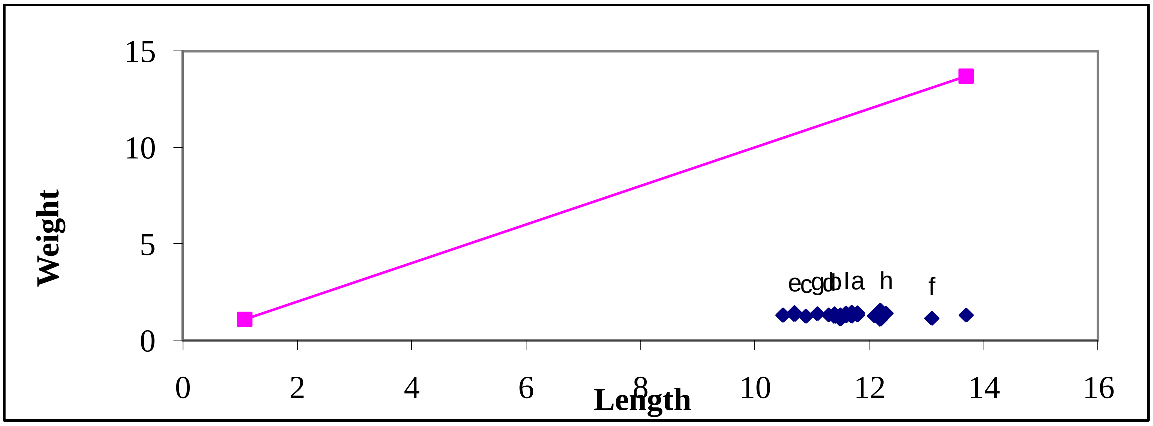

Figure-7. *Scatter plot of total length and body weight of Lingula anatina at S-III, LTL during study period.*

4. Discussion

Growth is manifested as an increase in size of the macrobenthic fauna and as such is best measured in terms of its volume or weight. It has been mathematically proved that there is a fairly constant relationship between length and weight of the species. Therefore, when knowledge of the growth in volume of weight is required, it is usually calculated from length-weight relationship [11]. The relationship is also useful in evaluating the general condition or well-being of the macrobenthic species through the study of condition factor (K) or relative condition factor (Kn) [12]. Relative condition factor (Kn) demonstrates the well being of aquatic organisms [13] and provides information regarding the suitability of environment. [14] asserted the utility of the mathematical relationship between weight and length as a practical index of growth, maturity and general condition of organisms. The values of Kn are also informative about the fitness, gonadal development and life history [14]. In the present investigation a general attempt has been made to evaluate variation of condition factor in different study sites and tidal levels of studied species. Although mean lengths of *L. anatina* remain almost constant throughout the study period at all study sites, but site wise weight of these animals varied greatly. Parameter values for length-Weight relationship of ‘b’ were always less than 1(Table-1.) and it was indicated a negative allometric pattern which suggested that the length of *L. anatina* were increased faster than its weight. According to [14] and [15] the relative condition factor K_n is an indicator of general well being. The value of K_n was less than 1(Table- 4.) at all study sites and it was indicated that *Lingula anatina* used to live at this particular habitat where they were not in good condition. [16] Opined that k_n may vary with increasing length when average weight did not increase in direct proportion to cube of its length. The condition factor is strongly influenced by environment factors, gonad development, feeding and growth rate degree of parasitism of the biota. Different nutritional aspects, stages of maturity and time of recruitment might also affect the condition factor [17], [18].differences of the

5. CONCLUSION

The coefficient of correlation and't'- test analysis have revealed that there existed insignificant relationship between the **lengths (cm) and weight (gm)** of *Lingula anatina* and lengths (cm) and weight (gm) of studied animal at all three study sites were almost constant throughout the study period. The lower K_n value (‹1) highlighted that *Lingula anatina* used to live at these unfavorable condition during present study period.

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