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Length-Weight Relationships of Four Different Sea Cucumber Species in North-East Coastal Region of Sri Lanka

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ABSTRACT: A detailed investigation on length-weight relationship of four sea cucumber species, *Holothuria spinifera*, *Bohadschia marmorata*, *Stichopus naso*, and *Holothuria atra* found in the commercial catches of North-East coastal waters of Sri Lanka was conducted from May 2014 to September 2016. Minimum length and weight were recorded in *S. naso* while maximum size was recorded by *B. marmorata*. Length-weight relationship was carried out to investigate the correlation coefficient (r), exponent “ b ” value and condition factor (K). Calculated length-weight relationships obtained for *H. spinifera*, *B. marmorata*, *S. naso* and *H. atra* were $W = -1.824 L^{1.887}$, $W = 0.080 L^{1.108}$, $W = 0.012 L^{1.021}$, and $W = -0.110 L^{1.234}$, respectively. Correlation coefficient for length-weight relationship ranged from 0.696 to 0.774 and was significant at $P < 0.01$ indicating good correlation between length and weight. The “ b ” values of *H. spinifera* (1.887), *B. marmorata* (1.108), *S. naso* (1.021) and *H. atra* (1.223) were significantly different ($P < 0.05$) from the hypothetical value of 3, showing a negative allometric growth pattern. The mean condition factor (K) was greater than 1; *H. spinifera* (3.89 ± 1.03), *B. marmorata* (4.12 ± 2.21), *S. naso* (3.558 ± 1.73) and *H. atra* (2.688 ± 1.34) indicating the good nutritional condition in all four sea cucumbers species.

Keywords: Allometric growth, coastal waters, *Holothuria spinifera*, length-weight relationship

INTRODUCTION

There are 75 known species of sea-cucumbers found in inter-tidal areas of Sri Lanka (Clark and Rowe, 1971). Most of the sea-cucumber catch comes from North, East and North-west regions of Sri Lanka. At present around 25 sea-cucumber species have been identified, while 21 species are considered as commercially important (Dissanayake & Stefanson, 2010). However, seven species of sea-cucumbers belonging to two families have been recorded from Point Pedro and Mullaitivu coastal waters in North-east region of Sri Lanka (Veronika *et al.*, 2016; Veronika *et al.*, 2017). Among them, *Holothuria atra* (Jaeger, 1833), *Bohadschia marmorata* (Jaeger, 1833), *Stichopus naso* (Samper, 1868) and *Holothuria spinifera* (Theel, 1886) have a higher demand than other species.

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Length-weight relationship is of great importance in fishery assessments of aquatic species (Garcia *et. al.*, 1998; Haimovici and Velasco, 2000). It is essential to estimate the average weight at a given length group and also useful to convert growth-in-length data to growth-in-weight in stock assessment models (Beyer, 1987). A detailed knowledge on ratio of the length to the weight for different stock species provides vital information in fisheries management. Furthermore, condition factor is a very useful index to determine well-being or relative fatness of an organism and the status of the aquatic ecosystem (Le- Cren, 1951). However, published information is not available till date on length weight relationship of sea-cucumber species from coastal waters around North-east region of Sri Lanka. Therefore, the present study was carried out to describe the length-weight relationship of four species *H. atra*, *B. marmorata*, *S. naso* and *H. spinifera* in North-east region of Sri Lanka.

MATERIALS AND METHODS

Sample collection

Random samples of sea-cucumbers were collected monthly from the commercial catches between May 2014 to September 2016 in main landing sites at Point Pedro and Mullaitivu in North-east region of Sri Lanka. External morphology of collected sea-cucumbers are shown in (Figure 1).

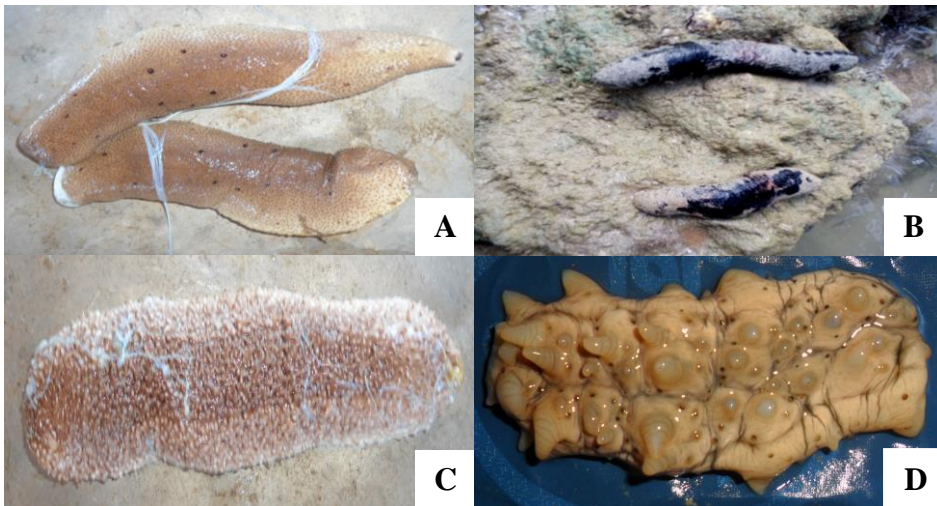


Figure 1. External morphology of (A) *Bohadschia marmorata*, (B) *Holothuria atra*, (C) *Holothuria spinifera*, (D) *Stichopus naso*

Determination of Length-weight

Samples were allowed to drain for 2 minutes before being weighed. All collected sea-cucumbers were individually weighed and measured to determine length-weight relationship. Length was measured to the nearest 0.5 cm using flexible tapes as the distance between the mouth and the anus, while weight was taken to the nearest 1 g with a spring scale. Length-weight relationship was estimated using the power function (Eq. 01) according to (Pauly, 1983)

$$W = a L^b \dots\dots\dots(\text{Eq. 01})$$

Where, W = Weight in g, L = Length in cm, a = Intercept, b = Slope

The values for *a* and *b* were calculated from the log transformed values of length and weight, i.e. $\text{Log } W = \text{log } a + b \text{ Log } L$, by least squares regression method. The coefficient of determination (R^2) that is the degree of relation between the length and weight was computed by the linear regression analysis: $R = r^2$.

Fulton’s condition factor (K) was analyzed according to (Pauly, 1983) using the (Eq. 02)

$$K = 100W/L^3 \dots\dots\dots(\text{Eq. 02})$$

Where, K = Condition factor, W = weight in g, L = Length in cm

Data analysis

The b-value for each species was tested by Student t-test to find out whether the b values are significantly different from the predictions for isometric growth (b=3), using Eq. 03.

$$[t=b-3/Sb] \dots\dots\dots(\text{Eq. 03})$$

Where, b = Regression coefficient, Sb = Standard error of ‘b’

Microsoft excel data analysis program was used for data analysis Thomas *et al.* (2003).

RESULTS AND DISCUSSION

Size distribution of sea-cucumbers in term of length and weight in North-east coastal waters of Sri Lanka indicated that *S. naso* has the minimum length and weight, while *B. marmorata* exhibited the maximum size (Table 1).

Table 1. Size distribution of sea-cucumbers in north-east coastal region of Sri Lanka

Species	Length (cm)		Mean± STD	Weight (g)		Mean± STD
	Min	Max		Min	Max	
<i>Holothuria spinifera</i>	14	22	19.5±2.16	115	411	286±76.23
<i>Bohadschia marmorata</i>	17	34	22±4.65	280	831	516±160.26
<i>Stichopus naso</i>	11	25	18±3.19	136	345	194±52.35
<i>Holothuria atra</i>	14	32	23±5.33	126	732	245±122.63

Length and weight ranges of *B. marmorata* and *H. atra* in North-east region reported were found to be lower than the respective values of both species found in North-west coastal region of Sri Lanka as reported by (Dissanayaka and Wijeyaratne, 2007) indicating that overall conditions in North-west are better than that in North-east region. Mean length and weight of *H. atra* recorded in East cost of Sri Lanka were 23.3±1.3 cm and 111±6, g respectively (Dissanayaka and Stefansson, 2010). Reasons for deviations of these

observations have to be investigated. However, length and weight data of *H. spinifera* and *S. naso* were not available in order to compare their present status. The parabolic relationship between length and weight of four sea cucumber species in North-east coastal waters are given in Figures. 2, 3, 4 and 5.

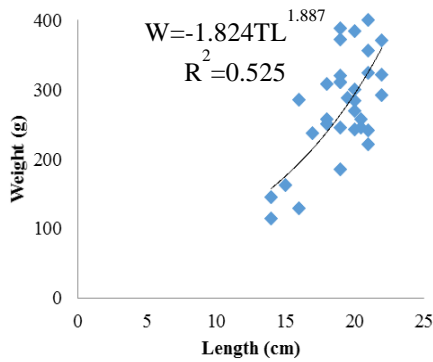


Fig 2. Parabolic relationship between length (cm) and weight (g) of *H. spinifera*.

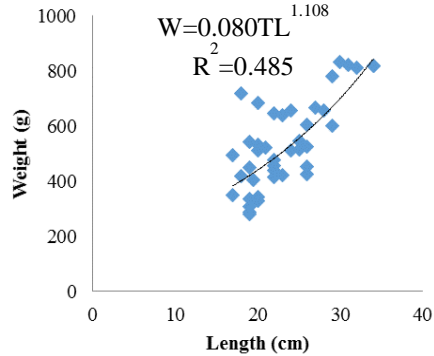


Fig 3. Parabolic relationship between length (cm) and weight (g) of *B. marmorata*.

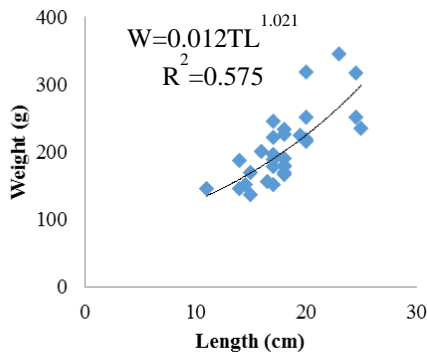


Fig 4. Parabolic relationship between length (cm) and weight (g) of *S. naso*

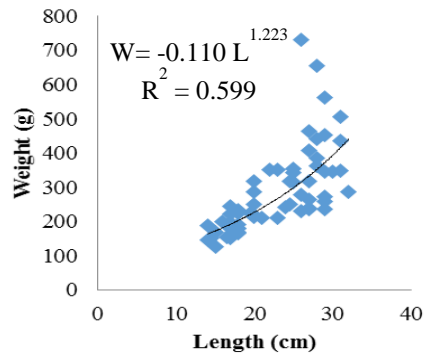


Fig 5. Parabolic relationship between length (cm) and weight (g) of *H. atra*

The length-weight relationship, regression parameters and condition factor for four sea-cucumber species are given in Table 2.

Table 2. Length-weight relationship, regression parameters and condition factor (K) of four sea-cucumber species collected from North-east coastal region of Sri Lanka

Species	Length-Weight relationship	Logarithmic transformation	n	r (R ²)	a	b	Mean K ± STD
<i>H. spinifera</i>	$W = -1.824 L^{1.887}$	$y = 1.887x + 0.015$	67	0.725	-1.824	1.887	3.898 ± 1.03
<i>B. marmorata</i>	$W = 0.080 L^{1.108}$	$y = 1.108x + 1.203$	83	0.696	0.080	1.108	4.125 ± 2.21
<i>S. naso</i>	$W = 0.012 L^{1.021}$	$y = 1.021x + 1.027$	61	0.758	0.012	1.021	3.558 ± 1.73
<i>H. atra</i>	$W = -0.110 L^{1.234}$	$y = 1.223x + 0.777$	62	0.774	-0.110	1.223	2.688 ± 1.31

Correlation coefficient (r) for length-weight relationship ranged from 0.696 to 0.774 (Table 2) and showed highly significant relationship between length and weight of collected sea cucumber species. Furthermore, Figures 2, 3, 4 and 5 showed coefficient of determination (R^2), which described contribution of independent variable to dependent variable, indicating that the contribution of length to weight for *B. marmorata*, *H. spinifera*, *S. naso* and *H. atra* were 48.5%, 52.5%, 57.5% and 59.9%, respectively.

Analysis of length-weight relationship of *H. spinifera*, *B. marmorata*, *S. naso* and *H. atra* (Table 2) showed that the respective values of b were 1.887, 1.108, 1.021 and 1.223, which were significantly ($P < 0.05$) lower than the regression coefficient of 3. Pauly (1983) revealed that the regression coefficient b in length-weight relationship of marine organisms is usually 3. If $b=3$, growth is isometric where length increment is proportionate to weight increment. If it is greater than 3, the growth is positive allometric and if it is lower than 3, the marine organism exhibits negative allometric growth. Thus, in the present study the b values were less than 3 indicating negative allometric growth, where length increment is greater than weight increment (Table 2). Most of the sea-cucumber species have elongated bodies in North-east coastal waters in Sri Lanka. Negative allometric growth of *H. spinifera*, *B. marmorata*, and *H. atra* are also reported by (Venkataraman, 2007) in Gulf of Mannar, India. However, the value of b in length-weight relationship of species could vary according to their locality and fishing season (Medina-Reyha, 2001; Prasad, 2001).

Condition factor is used to compare the well being of an organism and the health of the environment (Pauly, 1983). The mean condition factor (K) for *H. spinifera*, *B. marmorata*, *S. naso* and *H. atra* ranged between 2.688 ± 1.34 and 4.125 ± 2.21 (Table 2), Indicating that all sea-cucumber species were in good physical condition

CONCLUSIONS

The four sea cucumber species studied *H. spinifera*, *B. marmorata*, *S. naso* and *H. atra* in North-east coastal waters of Sri Lanka showed strong length-weight relationship and negative allometric growth pattern. The North-east coastal water region provides healthy environment for sea-cucumber growth. The present study has provided baseline information on length-weight relationship and condition factor for sustainable management of sea-cucumber resources. A detailed study on spatial difference of length-weight relationship of male and female sea-cucumbers and monthly variation of condition factor is needed for better fisheries management.

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