

Length-Weight Relationship and Condition Factors of Sea Cucumber on Mare and Moti Islands Conservation Areas in North Maluku

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Abstract

This work aimed at determining the growth patterns and condition factors of three sea cucumber species, namely *Holothuria atra*, *Bohadschia marmorata*, and *B. vitiensis* in seagrass beds of Mare and Moti Islands. Samples were collected in March 2023 using a roaming survey method in a block area with an area of 5000 m². As amount of 54 sea cucumbers were analysed from Mare Island and 58 individuals from Moti Island. The results of this study indicate that the correlation (*r*) length-weight relationship for the three sea cucumber species is stronger ($r > 0.6$) on Moti Island than Mare Island. *H. atra* and *B. marmorata* have a negative allometric growth pattern, while *B. vitiensis* has a positive allometric growth pattern on both islands. The Fulton condition factors for the sea cucumbers assessed on Mare Island were recorded for *H. atra* of 2.84 ± 2.01 , *B. marmorata* of 3.13 ± 2.47 and *B. vitiensis* of 9.24 ± 5.73 . Meanwhile, at Moti Island were found for *H. atra* of 12.49 ± 11.66 , *B. marmorata* of 9.58 ± 7.38 , and *B. vitiensis* of 8.87 ± 3.68 . This is indicated that all sea cucumber species are in good physical condition. Meanwhile, the relative weight condition factor (*Wr*) of the three species of sea cucumbers on both islands were in the range above 100, which indicated a food surplus in their habitat. The results of this research can be important as the preliminary data in terms of sustainable management of sea cucumber stocks in North Maluku.

Keywords: sea cucumbers, growth pattern, condition factor, North Moluccas

INTRODUCTION

Sea cucumber is one of the essential marine resources which has the potential fisheries both ecologically and economically. Ecologically, sea cucumber act as the bioturbators in fertilizing local waters and also as the key species in determining the balance of benthic communities (Setyastuti *et al.*, 2019; Arya *et al.*, 2022). Economically, sea cucumber has high commercial values due to high nutritional content which can be used as functional food (Widianingsih *et al.*, 2016). Additionally, sea cucumbers also have bioactive compounds as antibacterials and antioxidants which can be beneficial to the pharmaceutical and medicine industries (Rasyid *et al.*, 2023). More than 400 species of sea cucumbers are known living in Indonesian waters and 56 of them have been used for trade with export purposes (Setyastuti *et al.*, 2019). This will certainly encourage the level of exploration and exploitation of sea cucumbers for export interest. Pattinasarany and Manuputty (2018) stated that sea cucumber species such as *Holothuria atra*, *B. marmorata* and *B. vitiensis* are often traded both fresh and dried in the modern markets of Hong Kong and Guangzhou, China. Export demand at relatively high prices has triggered intensive fishing for sea cucumbers which will suspected reducing the natural population (Conand and Muthiga 2007). The increase in consumption of sea cucumbers in the Asian region has driven the overexploitation of more than 70% of sea cucumbers worldwide. For this reason, it is necessary to increase biological knowledge such as the length-weight relationship of sea cucumbers in order to obtain a sustainable management of sea cucumber fisheries (González-Wangüemert *et al.*, 2018).

According to Froese (2006) that the length-weight relationship and the Fulton condition factor (*K*) are two parameters used in fisheries management. Studying the length-weight relationship is indispensable since it would be able to provide the information on the growth patterns of sea cucumbers in nature, information on their habitat and the general health status of sea cucumbers (González-Wangüemert *et al.*, 2018, Panuluh *et al.*, 2019). Meanwhile, the condition factor value can provide the information on the physiological and morphological state of the species such as body shape, fat content and growth rate, energy reserves and organism health (Mozsar *et al.*, 2014; Aydin,

2020). Moreover, condition factors can also describe the availability of food in nature or the balance between predators and prey (Muchlisin *et al.*, 2014; Panuluh *et al.*, 2019). Research on the length-weight relationship and condition factors of several sea cucumbers species has been carried out in several places both domestically and abroad, including sand sea cucumbers (*H. scabra*) in Suli Waters, Central Maluku (Manuputty, 2019), black sea cucumbers (*H. atra*) in Karimunjawa Marine National Park area (Panuluh *et al.*, 2019), and on Panjang Island-Jepara (Permata *et al.*, 2021), *H. atra*, and *H. scabra* in Morella Waters, Central Maluku (Ongkers *et al.*, 2018), *H. atra*, *H. scabra*, and *Bohadschia marmorata* in Maluku waters (Luhulima, *et al.*, 2020). Subsequently, in several other places in the world, including *H. spinifera*, *H. atra*, *B. marmorata*, and *Stichopus naso* in Sri Lanka (Veronika *et al.*, 2018), four species from the Genus *Holothuria* namely *H. arenicola*, *H. atra*, *H. pardalis*, and *H. verrucosa* in the Karachi Coast-Northern Arabian Sea (Ahmed *et al.*, 2018), four other species from the Genus *Holothuria* namely *H. tubulosa*, *H. polii*, *H. mammata*, and *H. sanctori* in Aegean waters, Turkey (Aydin, 2020), *H. verrucosa*, *H. pardalis* (Ahmed *et al.*, 2020), *Stichopus cf. monotuberculatus* in the Southern Great Barrier Reef, Australia (Gray *et al.*, 2023), *H. arguinensis*, *H. mammata* in the Northeast Atlantic, *H. polii* and *H. tubulosa* in the Mediterranean (González-Wangüemert (2018).

The potential for sea cucumber is quite prospective in North Maluku, since it is one of the seafood commodities that is exported (Agus, 2018). However, there are lack of studies regarding the length-weight relationship aspects of sea cucumbers available. According to Gray *et al.*, (2023), the availability of biological data such as the length-weight relationship of various types of sea cucumbers is necessary because it can provide an overview of growth and biomass estimates for stock assessment. Sea cucumber resources can be found on Mare Island and Moti Island, where are the small volcanic islands located on the west side of Halmahera Island in North Maluku Province which have been designated as Conservation Areas through Minister of Maritime Affairs and Fisheries Decree No. 66 of 2020 for Mare Island and the Decree No. 104 of 2020 for Moti Island, both with Aquatic Tourism Park (TWP) status. It is suspected that the use of these sites as the tourist destination by tourists could have an impact on the condition of this marine ecosystem, including the sea cucumber population. This is based on the research carried out by Panuluh *et al.* (2019) that the presence of visitors in the Karimunjawa Marine National Park can affect water quality and food availability for the *H. atra* sea cucumber population. Three species of sea cucumber, namely *Holothuria atra*, *Bohadschia marmorata*, and *B. vitiensis* can be found in the seagrass ecosystem on Mare and Moti Island. Ecologically *H. atra* play an important role in recycling nutrients (Viyakarn *et al.*, 2020). Another important value of *H. atra* is its content of bioactive compounds as antibacterial (Sulardiono *et al.*, 2019), while *B. marmorata* has antifungal, antibacterial and anticancer compounds (Kandeil *et al.*, 2022). *H. atra* and *B. marmorata* are a group of low-value sea cucumbers while *B. vitiensis* is included in the medium value sea cucumber category (Setyastuti *et al.*, 2019). According to Omar *et al.*, (2013), *B. vitiensis* is a type of sea cucumber with important economic value and is often harvested commercially, which is suspected to reduce its population in nature. Furthermore, Kongsap *et al.*, (2023), recorded that overexploitation of high-value sea cucumber species has shifted the focus of fishing to low-value sea cucumber species such as *H. atra*. To date, there is no data available on the size of sea cucumbers and their condition factors on Mare and Moti Island. The availability of this information is important as a basis for future management of sea cucumbers, considering their important value both ecologically and economically, the availability of stocks in nature and their utilization which is still low on the two islands. Therefore, this study aims to analyze the length-weight relationship and condition factors of three sea cucumber species, namely *H. atra*, *B. marmorata*, and *B. vitiensis* found on Mare and Moti Islands.

MATERIALS AND METHODS

Samples collection was carried out in March 2023 on Mare and Moti Islands. Mare Island with an area of 20 km² is geographically located at 0°33' - 0°35' N and 127°22' - 127°24' E (DKP Malut Province, 2019) and is administratively included in the Tidore Islands City area, with a population of ±965 people spread across two villages, namely Maregam and Marekofo (BPS Tidore Islands City,

2019). Meanwhile, Moti Island with an area of 24.6 km² is administratively included in the Ternate City area and geographically located at 0°43' - 0°48' N and 127°38' - 127°22' E with a population of ±4797 people spread out in six sub-districts, namely Motikota, Figur, Tadenas, Tafaga, Tafamutu and Takofi. (Roemantyo, 2010). These two islands have not yet properly explored their fishery resources, one of which is sea cucumber resources. Each island consists of two research stations, namely Maregam Village (Station 1) and Marekoko Village (Station 2) on Mare Island, while on Moti Island consists of Tafamutu Village (Station 3) and Figur Village (Station 4). Locations and research stations are shown in Figure 1.

Sampling was carried out in the seagrass meadows using a roaming surveys method in a block area measuring 100 m x 50 m (5000 m²) at each research station. Roaming surveys were carried out with the assumption that the sea cucumber population was distributed unevenly. Sampling of sea cucumbers in the block area was carried out at low tide at night assuming that they appear in a large number as they are nocturnal. Samples of sea cucumbers found in the research area block were taken and put in a cool box for further analysis in the laboratory. Identification of sea cucumber types refers to Sadili *et al.*, (2015). Measuring the total length of sea cucumbers uses a ruler with an accuracy of 0.1 cm, while measuring the weight of sea cucumbers uses a digital scale with an accuracy of 0.1 gram. Analysis of the relationship between length and weight of sea cucumbers with the regression equation proposed by Ahmed *et al.*, (2018):

$$W = aL^b$$

Where W is the total weight of the individual (grams), L is the total length (cm), a is the regression intercept, and b is the slope of the curve. The growth criteria for sea cucumbers are categorized as isometric growth if the b value = 3, positive allometric growth if the b value >3 and negative allometric growth if the b value <3.

The condition factors analyzed in this research are Relative Weight (W_r) and Fulton Condition Factor (K). The relative weight condition factor is calculated based on the Richter (2007) equation:

$$W_r = (TW/W_s) \times 100$$

Where W_r is the relative weight, TW is the total weight of sea cucumbers, and W_s is the standard weight predicted from existing samples, calculated from a combined length-weight regression through distance between species with the equation: W_s = aL^b

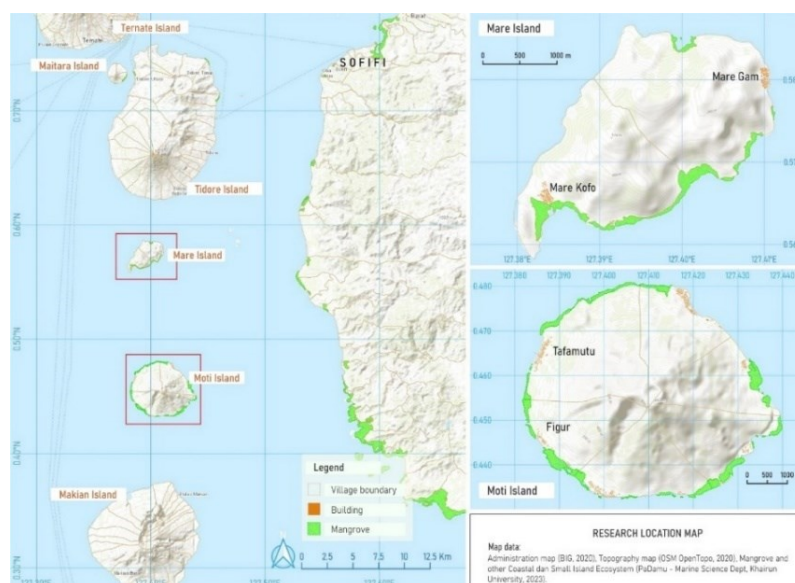


Figure 1. Research locations on Mare Island and Moti Island, North Maluku

Meanwhile, the Fulton Condition Factor (K) is calculated referring to the equation proposed by Okgerman (2005):

$$K = W/L^3 \times 100$$

Where K is the condition factor, W is the total weight (grams), L is the total length (cm) and 3 is the length coefficient (correction factor) to ensure the K value tends to be 1.

All analyzes were carried out using MS Excel 2021 software and the results were displayed in the form of tables and graphs.

RESULTS AND DISCUSSION

The total number of individual sea cucumbers from three species, namely *Holothuria atra*, *Bohadschia marmorata* and *B. vitiensis* collected and analyzed in this study, was 54 individuals from Mare Island and 58 individuals from Moti Island. *H. atra* was found in greater numbers, 24 individuals each on Mare Island and 37 individuals on Moti Island, while *B. vitiensis* was found in smaller numbers, namely 8 individuals on Mare Island and 10 individuals on Moti Island. The length of the *H. atra* found on Mare Island ranges from 10 cm – 23.5 cm and the weight ranges from 29.25 gr – 239.53 gr, while on Moti Island, *H. atra* has a length ranging from 5.0 cm to 20 cm and weight ranges from 11.21 gr to 158.96 gr. The length of *B. marmorata* obtained on Mare Island has a length range of 11 – 24 cm and a weight range of 30.15 – 239.53 gr, while on Moti Island the length ranges from 5.8 – 24.0 cm and a weight ranging between 34.4 gr – 167.47 gr. *B. vitiensis* on Mare Island were found with a length ranging from 12 – 24 cm and a weight range of 19.37 – 1363.33 gr. While on Moti Island, the length ranged between 14.0 – 23.0 cm and a weight ranging between 89.68 – 1204.07 gr. In general, it can be said that the *H. atra* and *B. marmorata* sea cucumbers found on Mare Island have higher average length and weight values compared to those found on Moti Island. Although *B. vitiensis* are found in small numbers, they have a higher length and weight than *H. atra* and *B. marmorata* on the two islands. A brief description of the data on the length and weight of the three sea cucumber species found on the two islands is shown in Table 1. The size of the *H. atra* found on the two islands is smaller than that reported by Ongkers *et al.*, (2018) in Morela, Maluku and Veronika *et al.*, (2018) in Sri Lanka with sizes of 9.6 – 31.6 cm (average 18.16 ± 4.42), and 14 – 32 cm (average 23 ± 5.33), respectively. Likewise, *B. marmorata* in this study was smaller than that reported by Veronika *et al.*, (2018) in Sri Lanka with a size of 17–34 cm (average 22 ± 4.65).

The growth pattern of a species can be determined from the allometric growth exponent (b) which is obtained from the length-weight relationship (Froese, 2006; Mulfizar *et al.*, 2012; Muchlisin *et al.*, 2014; Panuluh *et al.*, 2019; Gray *et al.*, 2023). In this work, the results of the relationship between

Table 1. Length-weight distribution of each sea cucumber species at the research location

Research location	N	Length (cm)			Weight (gr)		
		Mean±STD	Min	Max	Mean ±STD	Min	Max
<i>Holothuria atra</i>							
Mare Island	24	16,22±4,17	10,0	23,5	100,64±62,72	29,25	239,53
Moti Island	37	10,36±4,6	5,0	20,0	70,56±33,85	11,21	158,96
<i>Bohadschia marmorata</i>							
Mare Island	19	15,47±2,79	11,0	24,0	103,37±57,86	30,15	239,53
Moti Island	11	11,109±5,548	5,8	24,01	72,10±38,46	34,4	167,47
<i>B. vitiensis</i>							
Mare Island	8	18,87±4,01	12,0	24,0	712,90±456,54	19,37	1363,44
Moti Island	10	20,3±2,79	14,0	23,0	792,26±348,04	89,68	1204,07

length and weight of the three species on Mare Island showed that *H. atra* has a b value of 0.8398, *B. marmorata* was 0.9425 and *B. vitiensis* was 5.1757, respectively. Meanwhile on Moti Island *H. atra* has a b value of 0.7072, *B. marmorata* was 0.7072, and *B. vitiensis* was 4.4657 as performed on Table 2. Froese (2006) explained that if the value of $b = 3$ then growth is isometric where the increase in length is proportional to the increase in weight. Moreover, if the value of $b < 3$ indicates a negative allometric growth pattern where the increase in length is greater than the increase in weight. If the $b > 3$ then growth is positive allometric, where the increase in length is smaller than the increase in weight. Thus, in this study, *H. atra* and *B. marmorata* were included in a negative allometric growth pattern since they have the b values of less than 3 ($b < 3$). On the other hand, *B. vitiensis* has a positive allometric growth pattern since the b values were more than 3 ($b > 3$). A graph of the length-weight relationship showing the differences in growth patterns of the three species on the two islands is distinctly shown in Figure 2 and 3. Negative allometric growth of the *H. atra* was also found in the waters of Karimunjawa (Panuluh *et al.*, 2019), in the waters of Panjang Island (Jepara) (Permata *et al.*, 2021), in the waters of Ambon, Saparua, Osi and Marsegu Islands, Maluku Province as well (Luhulima *et al.*, 2020). On other regions such as Morela waters in Maluku Province (Ongkers *et al.*, 2018) and in Sri Lanka respectively found the similar results (Gamage *et al.*, 2021; Veronika *et al.*, 2018). The negative allometric growth of *B. marmorata* is in accordance with that of found by Luhulima *et al.*, (2020) on the islands of Ambon, Saparua, Osi and Marsegu, Maluku Province, Gamage *et al.*, (2021) on the south coast of Sri Lanka and Veronika *et al.*, (2018) in the northeastern coast of Sri Lanka and Ahmed *et al.*, (2018) in the Arabian Sea. Meanwhile, for the *B. vitiensis* with a positive allometric growth pattern, data regarding its growth pattern has not been found elsewhere so it cannot be compared with the results found in this study. Nevertheless, several other species such as *Holothuria tubulosa*, *H. mammata* and *H. arguinensis* were reported to show a positive allometric growth pattern (González-Wangüemert, *et al.*, 2018).

Negative allometric growth patterns are often found in other sea cucumber species from the genus *Holothuria* (Ahmed *et al.*, 2018; Veronika *et al.*, 2018; Aydin, 2020), *Sticophus cf. monotuberculatus* (Gray *et al.*, 2023). Sea cucumbers with negative allometric growth patterns tend to have slightly thinner or lighter body walls as their length increases. Meanwhile, sea cucumbers with positive allometric growth patterns tend to have thicker bodies because weight increases faster than length (González-Wangüemert, *et al.*, 2018). This parameter can be used to determine whether a sea cucumber population becomes lighter or heavier as it grows, which is an important criterion in the sea cucumber trade. According to Mulfizar *et al.*, (2012) the positive allometric growth pattern of a particular biota indicates a favorable aquatic environment for that species. This indicates that the water environmental conditions in the seagrass ecosystem on Mare and Moti Island are more favorable for *B. vitiensis* sea cucumbers than the other two species of sea cucumbers.

The results of this work shows that the coefficient of correlation (r) value ranges from 0.2884 – 0.4814 on Mare Island, while on Moti Island ranges from 0.653 – 0.7773. This indicates that the relationship between length and weight of sea cucumbers on Mare Island is classified as a weak to moderate correlation, while on Moti Island is classified as a moderate to strong correlation. A high correlation coefficient (r) value indicates a close relationship between weight gain and length and vice versa (Muchlisin *et al.*, 2014; Mulfizar *et al.*, 2012; Gray *et al.*, 2023). According to Gray *et al.*, (2023), length can be a good predictor of weight if the value ($r > 0.6$) as found in the sea cucumber *Sticopus cf. monotuberculatus* ($r > 0.8$). Thus, it can be said that the correlation between length and weight of sea cucumbers on Moti Island is stronger than on Mare Island. The value of the coefficient of determination (R^2) for sea cucumbers on Mare Island ranges from 0.0832 – 0.2318, which means that only around 8% - 23% of the total variance in weight and length increase can be explained by the weight-length relationship graph, respectively and *B. marmorata*, *H. atra*, and *B. vitiensis* respectively (Figure 2). The highest determination coefficient (R^2) value was found in sea cucumbers on Moti Island which ranged from 0.4263 – 0.6042. This means that around 42.63% - 60.42% of the increase in weight of sea cucumbers occurs due to the increase in body length of sea cucumbers, while around 39.58% - 57.37% of the increase in weight of sea cucumbers is caused by other external factors, each of which was found in *H. atra*, *B. vitiensis*, and *B. marmorata* respectively (Figure 3). This

indicates that the growth of sea cucumbers on Mare Island is more influenced by external conditions. According to Hartati *et al.*, (2017) several external factors that can influence the growth of sea cucumbers are temperature, pH, dissolved oxygen, food and predators.

Table 2. Results of analysis of the length-weight relationship of three sea cucumber species at the research location

	Coefficient of determination (R)	Coefficient of correlation (r)	Slope (b)	Growth equation	Growth pattern
<i>Holothuria atra</i>					
Mare Island	0,1167	0,3416	0,8398	$W=8,3683L^{0,8398}$	Allometric negative
Moti Island	0,4263	0,653	0,553	$W=17,944L^{0,553}$	Allometric negative
<i>Bohadschia marmorata</i>					
Mare Island	0,0832	0,2884	0,9425	$W=6,9116L^{0,9425}$	Allometric negative
Moti Island	0,6042	0,7773	0,7072	$W=12,575L^{0,7072}$	Allometric negative
<i>B. vitiensis</i>					
Mare Island	0,2318	0,4814	5,1757	$W=0,0001L^{5,1757}$	Allometric positive
Moti Island	0,5064	0,7116	4,4657	$W=0,001L^{4,4657}$	Allometric positive

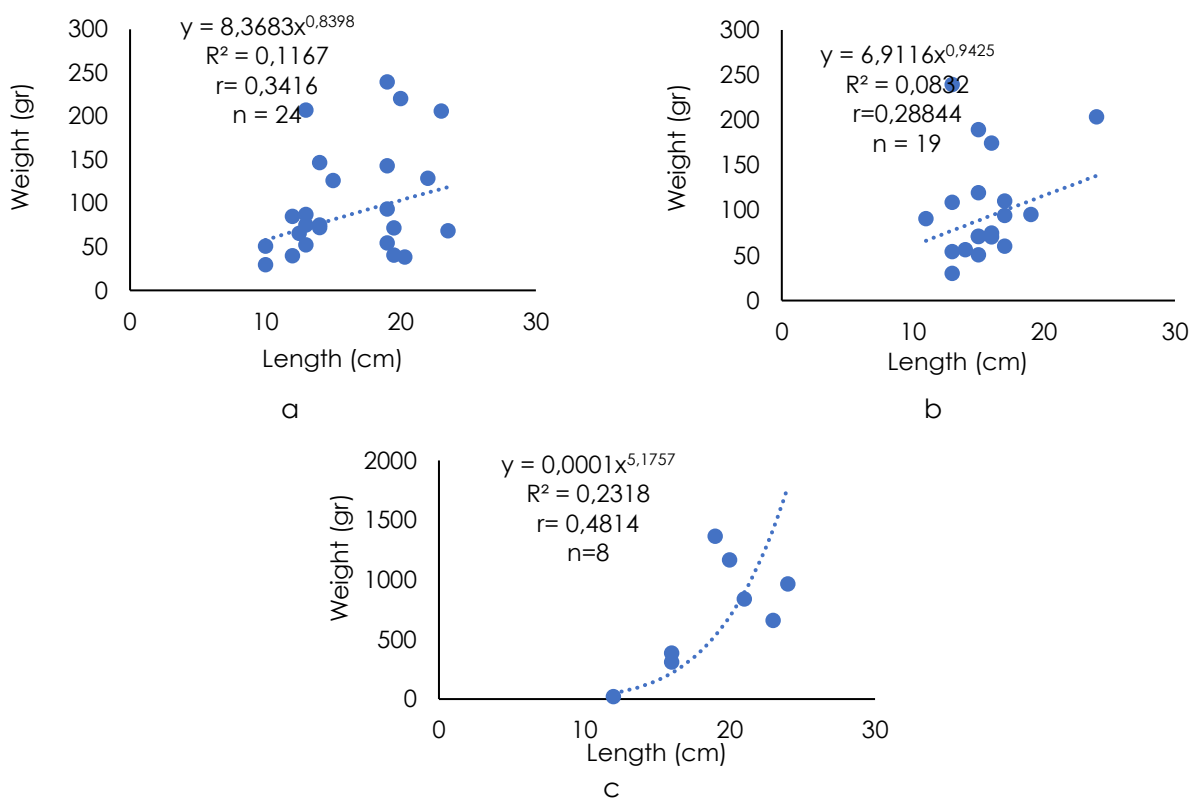


Figure 2. Length- weight relationship showing the different growth pattern of sea cucumbers: *H. atra* (a) and *B. marmorata* (b) have negative allometric growth pattern meanwhile *B. vitiensis* (c) has positive allometric growth pattern in Mare Island seagrass beds

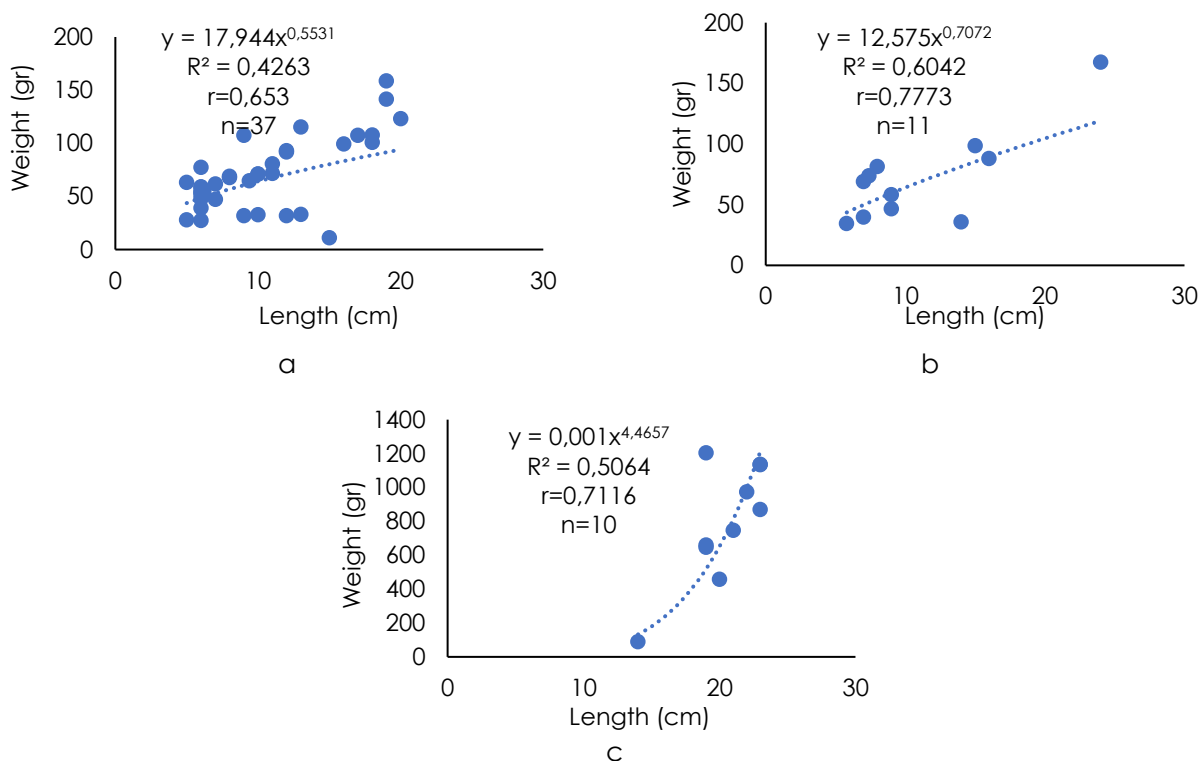


Figure 3. Length - weight relationship of sea cucumbers: *H. atra* (a) and *B. marmorata* (b) have negative allometric growth pattern meanwhile *B. vitiensis* (c) has positive allometric growth pattern in Moti Island seagrass beds

The existence of variations in the length-weight relationship of the three sea cucumber species (*H. atra*, *B. marmorata*, and *B. vitiensis*) found on these two islands (Mare and Moti), highlights that more data is still needed to obtain specific equations for the three species. This is related to weight estimation in future fisheries surveys to estimate biomass stock and catch volume of sea cucumbers (Gray *et al.*, (2023), especially economically important sea cucumbers such as *B. vitiensis* in North Maluku. In addition, data on environmental conditions is needed which is more specific to the habitat of the three species on the two islands which influences their growth. As stated by Manuputty (2019) and Permata *et al.*, (2021), several environmental factors such as temperature, salinity, dissolved organic matter, substrate, substrate pH and water pH and dissolved oxygen (DO) as well as current velocity, brightness and water depth can influence sea cucumber growth.

Two types of condition factors observed in this study are the Fulton condition factor and the relative weight condition factor. The average values of the Fulton condition factors and the relative weight of the three species found in the Mare Island seagrass meadows is *H. atra* which has a Fulton condition factor value of 2.84 ± 2.01 and the average relative weight condition is 115.92 ± 65.83 , the sea cucumber *B. marmorata* has a Fulton condition values of 3.13 ± 2.47 and the average relative weight condition is 113.95 ± 65.73 , while *B. vitiensis* has an average Fulton condition value of 9.24 ± 5.73 and the average relative weight condition was 156.18 ± 98.58 . Meanwhile, the two condition factor values, namely the Fulton condition factor and the relative weight of the three sea cucumber species found in the seagrass beds of Moti Island, namely *H. atra*, have a Fulton condition factor values of 12.49 ± 11.66 and the average relative weight condition is 109.08 ± 37.15 ; *B. marmorata* has a Fulton condition value of 9.58 ± 7.38 and an average relative weight condition of 105.84 ± 34.21 ; while *B. vitiensis* had an average Fulton condition value of 8.87 ± 3.68 and an average relative weight condition of 108.08 ± 49.07 (Table 3). The Fulton condition factor (K) values for the three types of sea cucumbers on both islands has a value of more than 1, which indicates that the nutrition of the three sea cucumbers is quite good. This is supported by Veronika *et al.*, (2018) and Panuluh *et al.*, (2019)

Tabel 3. Results of condition factor analysis of three species of sea cucumbers at the research location

Location	Fulton's Condition Factor (K)			Weight prediction (W)			Weight relative (W _r)		
	Mean±STD	Min	Max	Mean±STD	Min	Max	Mean±STD	Min	Max
<i>Holothuria atra</i>									
Mare Island	2,84±2,01	0,46	9,42	86,49±18,75	57,87	118,59	115,92±65,83	36,28	286,96
Moti Island	12,49±11,66	0,33	50,71	63,94±11,61	43,70	94,08	109,08±37,15	13,97	177,92
<i>Bohadschia marmorata</i>									
Mare Island	3,13±2,47	1,23	10,90	91,29±15,48	66,24	138,17	113,95±65,73	38,89	308,95
Moti Island	9,58±7,38	1,21	20,08	67,57±23,17	43,58	118,94	105,84±34,21	43,99	149,03
<i>B. vitiensis</i>									
Mare Island	9,24±5,73	1,12	19,88	567,82±480,52	38,51	1391,74	156,18±98,58	50,31	328,24
Moti Island	8,87±3,68	3,27	17,55	772,42±370,84	131,3	1205,22	108,08±49,07	68,30	234,49

that sea cucumbers that have a Fulton condition value of more than 1 tend to have better nutritional conditions. Apart from that, the high condition factor value of these three sea cucumber species is thought to be inseparable from their natural habitat in seagrass beds which provides food sources, microhabitats, protection against sun exposure, drought and stress at low tide (Kongsap *et al.*, 2023).

The condition factor values obtained by *H. atra* on Moti Island was higher than the other two types of sea cucumbers. According to Gamage *et al.*, (2021), the highest condition factor value for sea cucumbers recorded at a location indicates that the local environmental conditions are favourable and support the physical health of the individual organism. In addition, sea cucumbers with a higher condition factor values are expected to have higher fecundity than sea cucumbers with a low condition factor, because this is a form of adaptation to maintain their sustainability in nature. This is supported by Lampe-Ramdoe *et al.*, (2014), who stated that *H. atra* has a relatively higher reproductive rate compared to other sea cucumber species, besides that *H. atra* also has the ability to occupy diverse ecological niches. This also influences the presence of *H. atra* which is found in higher numbers than *B. marmorata* and *B. vitiensis* on the two islands. Meanwhile, the relative weight condition factor for the three sea cucumber species on the two islands is generally in the range of 100, which indicates that the seagrass habitat inhabited by the three sea cucumbers provides sufficient food or a low abundance of predators (Muchlisin *et al.*, 2014); Panuluh *et al.*, 2019). According to Panuluh *et al.*, (2019), apart from the availability of prey and the presence of predators, another factor that plays a role in influencing the values of the condition factor is the status of local fisheries management. For this reason, it is hoped that the results of this research can be used as an important basis regarding biological aspects of growth patterns and condition factors in the sustainable exploitation of sea cucumber fisheries in North Maluku.

CONCLUSION

The three species of sea cucumbers that were assessed namely *H. atra*, *B. marmorata* and *B. vitiensis* on Mare and Moti Islands showed the variations in the sizes and weight of the populations. *H. atra* and *B. marmorata* on Mare Island had a higher average length and weight than those on Moti Island. A negative allometric growth pattern was shown by *H. atra* and *B. marmorata*, while the *B. vitiensis* had a positive allometric growth pattern. The correlation (r) length-weight relationship for the three species was stronger (r>0.6) on Moti Island compared to Mare Island. The average Fulton condition factor values of more than 1 and relative weight (W_r) of more than 100 obtained by the

three species of sea cucumbers on the two islands indicated that local environmental conditions can support the life of the sea cucumber populations in this area. The results of this work can also be used as important preliminary data in the sustainable management of sea cucumber stocks as an essential economic value such as *B. vitiensis* on these two small islands.

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