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# Species and size composition of sea cucumber in coastal waters of UN bay, Southeast Maluku, Indonesia

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**Abstract**
Indonesia is one of the largest exporter sea cucumber in the world. However, information on this resource, especially in Maluku province is still lacking. Research to study species and size composition of sea cucumber was carried out in Un bay, Southeast Maluku on October to November 2013. Data of sea cucumber was collected by using belt transect. A total of 104 individuals belonging to 11 species from five genuses namely *Holothuria*, *Stichopus, Actinopyga, Bohadschia* and *Thelenota* were found during the study. Genus *Holothuria* had the most individuals whilst genera of *Actinopyga* and *Thelenota* had the least individual. Minimum size in term of length and weight represented by *Holothuria scabra* while maximum size belonged to *Stichopus variegates*. Further analysis on the most dominant species i.e. *H. scabra* showed that most of the individual consists of large size with the ratio between male and female was 1:0.51. Growth pattern of this species was negative allometric ($b < 3$).

**Keywords:** Sea cucumber, species and size composition, sex ratio, length-weight relationship.

## 1. Introduction
Information on the size composition of individuals harvested and length-weight relationship are important for management purposes [13]. Size distribution data provide knowledge about the impact of harvesting on the population and on the temporal and spatial distributions of individuals of different sizes [19]. Length-weight relationship is of great importance in fishery assessments. It is important to estimate the average weight at a given length group [2] and it is also useful for converting length observations into weight estimates to provide some measure of biomass through length frequency [10]. Furthermore, length-weight relationship can be used also to determine condition factor which is in turn determine well-being or relative fatness of an organism and the health of environment [15].
Sea cucumbers are important resources for coastal livelihoods. These resources are sometimes eaten locally, whereas the majority are boiled, dried and exported to the distribution centers in Asia such as Singapore, Hongkong and China [4]. Depending on species, size and quality of processing, retail price for dried sea cucumber is up to USD 300 - 500 per kg [22]. Sea cucumber fisheries are often artisanal or small-scale and in many developing countries, fishing by women and children is significant because sea cucumbers are easily harvested in shallow waters in the tropics [22].
Indonesia is one of the largest exporter sea cucumber in the world. There are 53 species of seacucumber in Indonesian waters with most of the catch come from eastern Indonesia particularly from Sulawesi and Maluku [5, 30]. Eventhough sea cucumber has been exploited for long time, information on this resource especially in Maluku province is still lacking. This research was conducted to fill the gap by investigating species and size composition of sea cucumber in Un bay, Southeast Maluku, Indonesia.

## 2. Materials and Methods
### 2.1. Study Area
Research to study species and size composition of sea cucumbers was conducted at seagrass beds of Un bay, Southeast Maluku (Figure 1) on October to December 2013. Seagrass in this area mainly consists of *Enhalus acoroides, Thalassia hempricii* and *Cymodocea rotundata* with the predominant substrates are coarse sand and fine sand, while mud, gravel, silt, crushed shell and crushed coral are spotted in certain area.

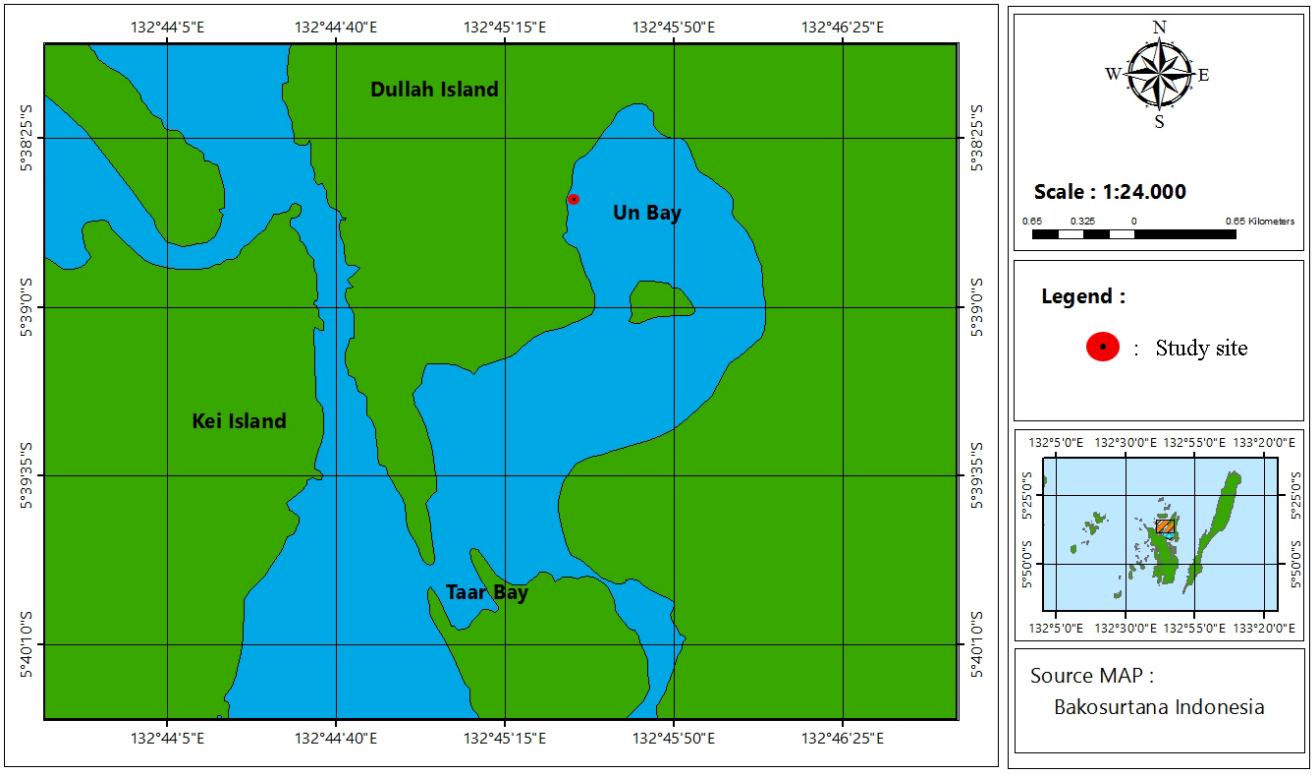


**Fig 1:** Map showing sampling site

### 2.2. Sample collection and analysis

A total of 11 (100 x 10m$^2$) belt transects were used to investigate sea cucumber community in Un bay. Sample of sea cucumber was collected during low tide by hand picking. Sea cucumber found in each transect were identified, counted and measured based on their sex. Species identification was based on [3, 5, 23], while sex was determined based on the general appearance (color and texture) of the gonads. Prior to measurement, sea cucumber was let to relax for about 10 minutes. Length was recorded as the distance between mouth and anus to the nearest mm using plastic rules while weight was weighted using digital balance.

Deviation of sex from normal ratio 1:1 for male and female was tested using chi-square with Yates' correction proposed by Fowler and Cohen (1990) [8]:

$$\chi^2 = \Sigma (|O - E|) - 0.5)^2 / E$$

Where: O = oberserved frequency
E = expexted frequency

Length-weight relationship was analysed using the power function according to Pauly (1984) [21]:

$$W = a L^b$$

Where: W = weight in gram
L = length in cm
a = intercept
b = slope

The value of b was then tested and used to determine growth pattern of sea cucumber i.e. isometric growth (b=3) or allometric growth (b≠3) by using *t-Student test* based on Pauly (1984) [21]. The interval value of b was calculated by using formula of Sparre and Venema, (1992) [26].

## 3. Results and discussion

### 3.1. Species composition

A total of 104 individual which consist of five genuses of sea cucumber namely *Holothuria* (four species), *Stichopus* (three species), *Actinopyga* (one species), *Bohadschia* (two species) and *Thelonota* (one species) were found in Un bay during the study (Table 1). Two species found in the present study i.e. *Holothuria scabra* and *Thelenota ananas* are considered as the most valuable species of sea cucumber in international market [4, 31]. Genus *Holothuria* had more species than other genuses. More species belong to genus *Holothuria* is also recorded by some authors such as [25] in Central Maluku waters (six species) and [31] in Pai Padaido (four species). Rowe (1969) [23] stated that genus *Holothuria* has the most species recorded in the world i.e. more than 114 species. Furthermore, Yusron (2009) [32] reported that genus *Holothuria* has more species than other genus of sea cucumber in Indonesian waters especially in Western Pacific. Number of species found in the present study is similar to the number of species recorded by some authors. Yusron (2004) [31] reported 10 spesies of sea cucumber in Pai Padaido; Lewerissa (2014) [17] found nine species in Porto, Saparua Island. Meanwhile, Yusron & Widianwari (2004) [33] found 14 species in Kai Besar, Lewerissa (2009) [16] reported 18 species in Porto and Warialau waters and Selanno *et al*. (2014) [25] recorded 22 species of sea cucumber in Central Maluku. More species of sea cucumber found by those authors above could be due to wider area or different habitat covered. Yusron & Widianwari (2004) [33] and Lewerissa (2009) [16] conducted their research not only in seagrass bed but also in coral reef. Whereas, Selanno *et al.* (2014) [25] conducted their study at wider area in three islands i.e. Ambon, Saparua and Haluku.

**Table 1:** Species composition and number of individual of sea cucumber in Un bay

| No. | Species | Local name | Number of individual | Percentage |
|---|---|---|---|---|
| 1. | *Actinopyga algonigra* | Teripang putih | 1 | 0.96 |
| 2. | *Bohadschia tenuissima* | Teripang getah | 1 | 0.96 |
| 3. | *Bohadschia similis* | Teripang olok-olok | 2 | 1.92 |
| 4. | *Holothuria albiventer* | Teripang susuan | 1 | 0.96 |
| 5. | *Holothuria coluber* | Teripang taikokong | 1 | 0.96 |
| 6. | *Holothuria nobilis* | Teripang lotong/batu | 1 | 0.96 |
| 7. | *Holothuria scabra* | Teripang pasir/gosok | 82 | 78.85 |
| 8. | *Stichopus horrens* | Teripang kacang | 3 | 2.88 |
| 9. | *Stichopus* sp | Teripang gamat | 1 | 0.96 |
| 10. | *Stichopus variegates* | Teripang gamat besar | 10 | 9.62 |
| 11. | *Thelenota ananas* | Teripang nenas | 1 | 0.96 |
| Total | | | 104 | 100 |

The results in Table 1 show that most individuals of sea cucumber found in this study belonged to genus *Holothuria* i.e. 85 individuals followed by genus *Stichopus* as many as 14 individuals, while the least individual is represented by genus *Actinopyga* and genus *Thelonata.* Higher abundance of genus Holothuria is also reported by Yusron (2004) [31] in Pai Padaido and by Selanno *et al.* (2014) [25] in Central Maluku. Higher number of sandfish (*H. scabra*; 82 individuals) found in this study might indicate that habitat in Un bay with substrate dominated by sand is suitable for this species.

### 3.2. Size distribution

Size distribution of sea cucumber in term of length and weight in Un bay is presented in Table 2. It can be seen in Table 2 that *H. scabra* has minimum length and weight while maximum size is represented by *S. variegates.* Information on size distribution and abundance of marine organism is important in managing marine resources. In high level of exploitation which cause overfishing is indicated by lesser catch and smaller animal caught (Wouthuyzen *et al.,* 1984) [29].

**Table 2:** Size distribution, mean (ȳ) and standard deviation (SD) of sea cucumber in Un bay

| Species | Length (cm) | | | | Weight (g) | | | |
|---|---|---|---|---|---|---|---|---|
| | Min | Max | ȳ | SD | Min | Max | ȳ | SD |
| *Actinopiga algonigra* | - | 16.0 | - | - | - | 100 | - | - |
| *Bohadschia tenuissima* | - | 27.0 | - | - | - | 430 | - | - |
| *B. similis* | 23.0 | 30.0 | 26.5 | 4.95 | 330 | 350 | 340 | 14.14 |
| *Holothuria albiventer* | - | 12.5 | - | - | - | 60 | - | - |
| *H. culuber* | - | 27.0 | - | - | - | 290 | - | - |
| *H. nobilis* | - | 24.0 | - | - | - | 180 | - | - |
| *H. scabra* | 9.5 | 23.5 | 17.7 | 2.70 | 80 | 450 | 233.5 | 80.61 |
| *Stichopus horrens* | 10.0 | 33.0 | 19.0 | 22.90 | 100 | 260 | 156.7 | 89.63 |
| *Stichopus sp* | - | 10.0 | - | - | 80 | - | - | - |
| *S. variegates* | 14.0 | 38.0 | 22.9 | 8.76 | 80 | 1350 | 396 | 384.5 |
| *Thelonota ananas* | - | 23.0 | - | - | - | 160 | - | - |

### 3.3. Length frequency distribution of *Holothuria scabra*

A total of 82 individuals of sandfish (*H. scabra*) were collected during the study, hence, further analysis was conducted for this species which covered length frequency distribution, sex ratio and length-weight relationship.

Length frequency distribution of *H. scabra* is presented in Table 3. The body length of *H. scabra* found in this study ranged from 9.5 to 23.3 cm. This finding is similar to the size of *H. scabra* population in Tanjung Tiram, Inner Ambon bay (Yusron, 1991) [30]. It can be seen in Table 3 that small individuals (< 9 cm) was not found in Un bay. This phenomenon is also reported by [1, 20, 30]. According to Mercier *et al.* (1999) [18] and Murphy *et al.* (2011) [20], small individuals of sea cucumber are rare or difficult to find in a certain area because of their habit to burry themselves in the substrates and only active during the night.

**Table 3:** Length frequency distribution of *Holothuria scabra* in Un bay

| No | Class interval (cm) | Midlength (cm) | Frequency (ind.) | Percentage |
|---|---|---|---|---|
| 1. | 9.0 – 9.9 | 9.5 | 1 | 1.21 |
| 2. | 10.0 – 10.9 | 10.5 | 2 | 2.43 |
| 3. | 11.0 – 11.9 | 11.5 | 0 | 0 |
| 4. | 12.0 – 12.9 | 12.5 | 1 | 1.21 |
| 5. | 13.0 – 13.9 | 13.5 | 3 | 3.65 |
| 6. | 14.0 – 14.9 | 14.5 | 7 | 8.53 |
| 7. | 15.0 – 15.9 | 15.5 | 8 | 9.75 |
| 8. | 16.0 – 16.9 | 16.5 | 14 | 17.07 |
| 9. | 17.0 – 17.9 | 17.5 | 13 | 15.85 |
| 10. | 18.0 – 18.9 | 18.5 | 8 | 9.75 |
| 11. | 19.0 – 19.9 | 19.5 | 13 | 15.85 |
| 12. | 20.0 – 20.9 | 20.5 | 6 | 7.31 |
| 13. | 21.0 – 21.9 | 21.5 | 3 | 3.65 |
| 14. | 22.0 – 22.9 | 22.5 | 2 | 2.43 |
| 15. | 23.0 – 23.9 | 23.5 | 1 | 1.21 |
| Total | | | n = 82 | 100 |

Data presented in Table 3 also shows that population of sandfish (*H. scabra*) in Un bay is dominated individuals at midlength 16.5, 17.5 and 19.5 cm which consist as many as 40 individuals (49%) of the total samples collected. According to Connand (1990) [6] first gonad maturity of *H. scabra* occurs at 16 cm, while Kithakeni and Ndaro (2002) [14] stated that its first spawning occurs at 16.8 cm. Based on those statements, it can be concluded that most of the individual *H. scabra* found in Un bay consists of adult individuals (73.2%) which have spawned at least once (Table 3; Figure 2).

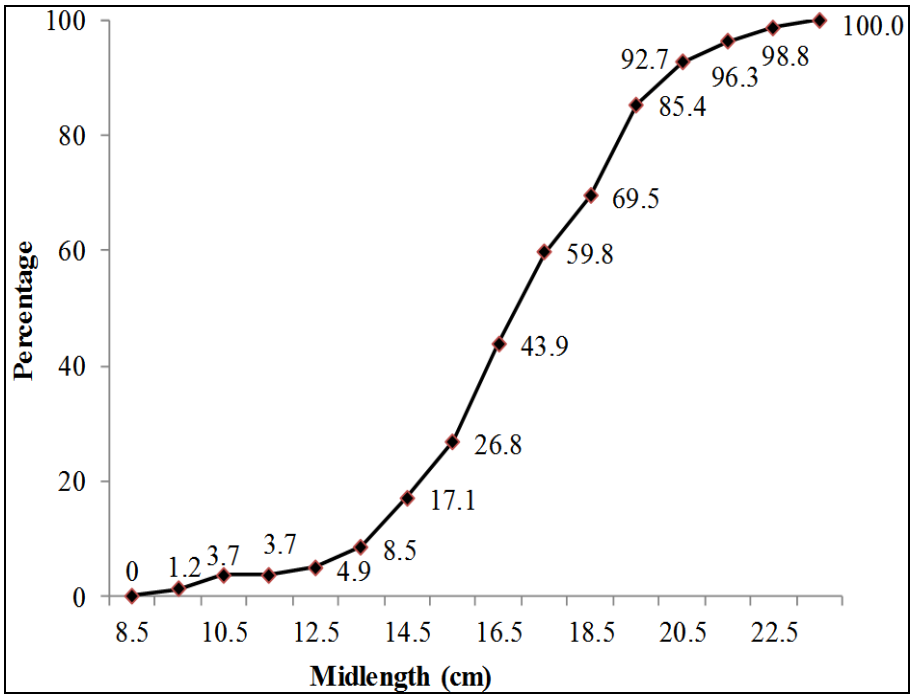


**Fig 2:** Relative cumulative frequency of length *Holothuria scabra* in Un bay

Large individual of *H. scabra* found in this area is not surprising because there is community based management called *sasi* applied for this resource (pers.comm.). *Sasi* system refers to temporal prohibition on particular resources e.g. sea cucumber and when it is applied (*tutup sasi*/closed season), no usage whatsoever is permitted until the *sasi* is lifted (*buka sasi*/opened season). Violation of the sasi system will cause fine for the violators which can be a sum of money or traditional goods like antique gongs or cannons [24].

### 3.4. Sex ratio

A total of 82 individual of sandfish (*H. scabra*) were collected in Un bay during the study. Of these individuals, 35 females and 18 males were sexed successfully, giving the sex ratio between male and female was 1:0.51. The results of chi-square analysis with Yates correction showed that calculated value of $\chi^2$ = 4.83 was larger than $\chi^2$ table (P=0.05; df=1) = 3.84 indicating deviation of sex ratio 1:1 for the favor of male *H. scabra*.

Sex ratio of *H. scabra* in this study is different with other studies conducted by [6, 7, 27]. However, some authors reported deviation of sex ratio of sea cucumber with more male than female such as Hartati and Yanti (2006) [11] for *H. vagabunda* and Hoareau and Conand (2001) [12] for *S. chloronotus*. According to Hoareau and Conand (2001) [12], more male than female individuals might be due to high mortality of adult and juvenile as well as larvae of female, high asexual reproduction (fission) of male and sex inversion in life cycle of sea cucumber from female to male. Furthermore Uthicke *et al.* (1999) [28] stated that more male *S. chloronotus* in Great Barrier Reef, Australia is caused by high mortality of recruitment and limited dispersal ability of female.

### 3.5. Length-weight relationship

Result of length-weight relationship of sandfish (*H. scabra*) is presented in Table 4. It can be seen in Table 4 that correlation coefficient (r) for length-weight relationship ranged from 0.653 to 0.826. These calculated values are larger than r table (critical value of r) for each degree of freedom (df=n-2) at P=0.01 which are ranging from 0.217 to 0.486 indicating highly significant relationship between length and weight of *H. scabra*. Furthermore, Figure 3 shows coefficient of determination ($R^2$) which describes contribution of independent variable to dependent variable ranged from 0.426 - 0.682) indicating contribution of length to weight for *H. scabra* are 42.6 - 68.2%.

**Table 4:** Length-weight relationship of *Holothuria scabra* in Un bay

| Sex | n (ind.) | W = a L $^b$ | r | t calc. | t table at P=0.05 | Ranged of b at P=0.05 |
|---|---|---|---|---|---|---|
| Male | 35 | $W=1.567L^{1.761}$ | 0.826 | 5.92* | 2.03 | 1.335 - 2.187 |
| Female | 18 | $W=6.037L^{1,264}$ | 0.653 | 4.73* | 2.12 | 0.487 - 2.042 |
| No sex id. | 29 | $W=0.516L^{2,127}$ | 0.811 | 2.96* | 2.05 | 1.521 - 2.733 |
| Pooled | 82 | $W=1.108L^{1.870}$ | 0.804 | 9.84* | 1.99 | 1.560 - 2.178 |

Legend: * significant different at P=0.05

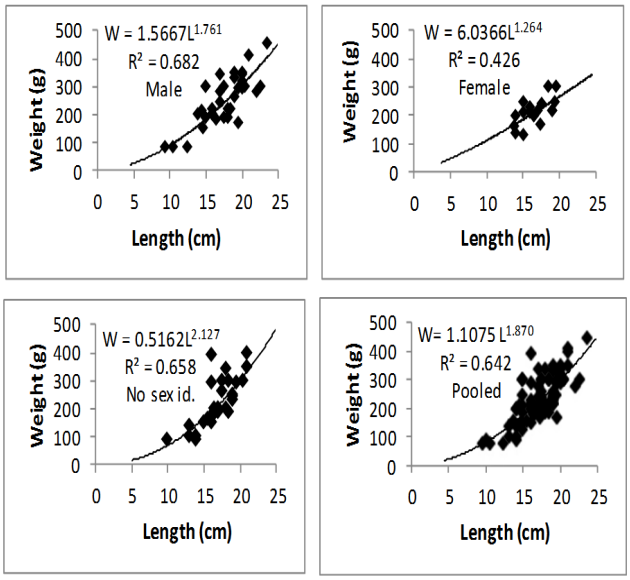


**Fig 3:** Length-weight relationship of *Holothuria scabra* in Un bay

Analysis of length-weight relationship of *H. scabra* in Table 4 and Figure 3 show that the values of b ranged from 1.264 to 2.127. The results of t-Student test show that calculated values of t are larger than the values of t table at P=0.05. Subsequent analysis to determine ranges of b at 95% Confidence Interval (P=0.05) show that value of 3.00 is not included in all ranges of b values (Table 4). Based on both analyses, it can be concluded that the values of b in these length-weight relationship are significantly different from 3 (b≠3). According to Pauly (1984) [21], the value of b in length-weight relationship can be used to determine growth pattern of marine organism. Furthermore, the author stated that if the value of b = 3, growth is isometric in which length increment is proportional to weight increment. On the contrary, if b ≠ 3, the growth is called allometric i.e. negative allometric (b < 3), length increment is faster than weight increment and positive allometric (b > 3), weight increment is faster than length increment. The results presented in Table 4 show that the values of b<3 indicating gowth pattern of *H. scabra* in Un bay is negative allometric in which length increment is faster than weight increment. Negative allometric growths of *H. scabra* are also reported by [1, 6, 30]. The value of b in length-weight relationship is not constant but could change depending on environmental factors, physiological conditions of the marine animal at the time of collection, sex, gonad development and food supply [9, 15].

## 4. Conclusion

It can be concluded that sea cucumber in Un bay, Southeast Maluku, Indonesia consists of 11 species with predominant species is *Holothuria scabra*. This species mostly consists of large individuals with more male than female which are showing negative alometric growth. More research is needed particularly on population dynamic and reproduction aspects of economic important species in order to ensure sustainability of sea cucumber in the area.

## 5. Acknowledgement

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