Size distribution of *Strombus luhuanus* Linnaeus, 1758 in Oma coastal waters, Central Maluku, Eastern Indonesia

S Haumahu, Pr A Uneputty and Y A Lewerissa  
Fisheries and Marine Science Faculty, Pattimura University  
Jln. Mr. Chr Soplanit, Kampus Poka, Ambon-Indonesia  
E-mail: sarah.haumahu@gmail.com

**Abstract.** *Strombus luhuanus* is a marine mesogastropod known as strawberry conch belongs to the Strombidae family. This species is consumed by the coastal community in Maluku province and collected by people at various shell size. The objective of this research was to determine the temporal size distribution and the size difference between its sexes. Sampling was conducted in Oma coastal water, Central Maluku, Eastern Indonesia. A specimen of *S. luhuanus* collected randomly during low tide from April to July 2018. Some characters of *S. luhuanus* were measured including shell length, shell width, spire height, and lip thickness. The result of this research showed that shell length of this species varied between 30.81 mm and 55.20 mm; the shell width varied from 16.33 mm to 32.25 mm; its spire height varied between 5.00 mm and 15.20 mm, while the lip thickness varied from 0.10 mm to 5.54 mm. The average of shell length, shell width and spire height of *S. luhuanus* were high in June sampling period compared to another sampling periods, whereas lip thickness of this species was high in July sampling. Based on its sex, the shell size parameters measured in our study were higher in female specimen than the male one. The size groups of this gastropods were dominated by 38.79-47.39 mm in shell length. Lip thickness of the shell showed that *S. luhuanus* was in developing stage of growth in this study and *S. luhuanus* showed sexual dimorphism.

**Key Words:** Gastropods, shell size, maturity, strawberry conch.

1. **Introduction**

*Strombus luhuanus* Linnaeus, 1758 is marine mesogastropods belong to the Strombidae family. Strombidae consists of five genera and 75 species. *S. luhuanus* was known as strawberry stromb. This species is distributed along tropical and subtropical Indo-Pacific and it is known as tropicopolitan marine gastropods [1].

*S. luhuanus* is found in the sandy bottom of the coral reef area, among seagrass and coral rubble. *S. luhuanus* also can be found in a coastal lagoon, bays and other protected areas, where the bottom substrate is devoid of mud. *S. luhuanus* commonly found in intertidal and shallow subtidal zone to a depth about 20 m [2, 3]. Besides that, Haumahu (2011) [4] stated that Strombus could be found in various ecosystems such as seagrass, and coral reefs in sandy muddy and coarse sandy substrate. As marine gastropods which found abundantly in the intertidal zone, *S. luhuanus* also abundant in Maluku coastal waters, especially in the intertidal zone with the bottom substrate, consists of coral rubble and seagrass.

*S. luhuanus* is important to the coastal community in Maluku Province as it was traditionally collected as food. This specimen is collected during the low tide with various shell size. During collecting periods, one can collect up to 100-150 individual of this species. Average numbers of people collected this gastropod were 10-15 people in one collecting area (personal observation). This activity can cause an overexploitation and habitat destruction. In order to maintain this species sustainability in the coastal area and its environment, we need a proper management strategy. One of the information needed for the management strategy is the biological aspect of this species including size distribution. When this species reach an adult size, *S. luhuanus* stop growing lengthwise, and the outer lip thickens to several millimetres and there is a slight flaring outwards of the lip [5].
objectives of this research were to determine the shell size distribution of *S. luhuanus* temporally and to determine the shell size differences between its sexes.

2. Materials and Method

2.1. Field work

Sampling was conducted in Oma coastal water, Central Maluku, Eastern Indonesia (Figure 1). Geographically, Oma village is situated on 3°37’50"S-3°37’25"S and 128°25’50"E-128°23’30"E. The substrates in this intertidal zone consist of a boulder, pebble, dead coral, coral rubble, and coarse sand. There are six species of seagrasses namely *Enhalus acoroides*, *Thalassia hemprichii*, *Cymodocea rotundata*, *Halophila minor*, *Halodule uninervis* and *Syringodium isoetifolium* found to distribute in coastal water of Oma village.

![Figure 1. Map of sampling site](image1)

Sampling was done on monthly basis from April to July 2018. The specimen of *S. luhuanus* were collected randomly during low tide. Some shell dimensions were measured including shell length (SL), shell width (SW), spire height (SpH) and lip thickness (LT) (Figure 2) using a digital vernier caliper to the nearest 0.01 mm.

![Figure 2. Morphometric (length, width, spire height, and lip thickness) of *S. luhuanus* measured in this study](image2)

Shell length is a distance between the apex and the tip of siphonal notch along the coiling axis. Shell width is the maximum distance perpendicular to the height at the last body whorl where the lip is thickness. Lip thickness measured from the outer lip three quarters the way along the siphonal canal.
Juveniles of *S. luhuanus* was characterized by lip thickness <2 mm and the mature (adult size) was >2 mm [7] (Figure 3 a & b).

**Figure 3.** Juvenile shells of *S. luhuanus* with lips less than 2 mm (a), and adult shells with lip thicker than 2 mm (b).

Sex determination of *S. luhuanus* was based on the presence of the penis in the male by macroscopic observation. The male specimen has an open-groove spade-like penis which is brownish black on the right dorsal side of the foot, whilst the female has a genital groove running across the foot into the pedal groove at the base of the anterior end of the foot [7].

2.2. Data Analysis

To determine the sex ratio of *S. luhuanus* found in this study, we used the formula according to Khouw (2016) [8]:

\[
NK = \frac{N_{JB}}{N} \times 100\%
\]

where NK = sex ratio; NJB = number of female or male of *S. luhuanus* and N = total number of *S. luhuanus* observed.

To analyze the frequency distribution of the shell, some parameters which were used in this study including shell length (SL), shell width (SW), spire height (SpH) and lip thickness (LT). Shell length of *S. luhuanus* was grouped in size class distribution. Number of class (\(k\)) in this size distribution following [9]: \(k = 1 + 3.3 \log n\) [9], where \(n\) = number of samples. Data were analyzed using Microsoft Excel 2013.

3. Result and Discussion

3.1. Abundance

Total 712 individuals of *S. luhuanus* was found in this study during April-July 2018 and it varied between sampling periods (Figure 4). This figure showed the highest abundance of *S. luhuanus* was found in July 2018 (255 individual) which consisted of 49.41% female and 50.59% male. Overall abundance of females *S. luhuanus* in this study was 52.81% and the males was 47.19%. Study on the same species at this site [10] found the highest abundance of *S. luhuanus* was found on February 2018. The difference in *S. luhuanus* abundances (may) caused by exploitation activities by coastal communities and this could lead to the decreasing of the abundance of this species.
The abundance of *S. luhuanus* found in Oma coastal waters from April-July 2018

3.2. Size distribution

Statistical analysis showed that overall shell dimension including shell length, shell width, spire height, and lip thickness was varied among sampling periods in this study. Shell length of this gastropod varied from 30.81-55.20 mm, shell width was from 16.33-32.25 mm, spire height was from 5.00-15.20 mm and lip thickness was from 0.10-5.54 mm (Table 1). Maximum shell length of *S. luhuanus* was 80 mm with a common shell length of 50 mm [3]. The maximum shell length found in this study was different compared to [3] and this might be due to the differences in environmental condition, sampling periods and fishing pressure activities. Coastal communities usually collect this species with adult size for their food.

Table 1. Shell dimension (mm) of *S. luhuanus* found in Oma coastal waters (mean & SD in parenthesis)

| Month  | SL            | SW            | SpH           | LT            |
|-------|---------------|---------------|---------------|---------------|
| April (all) | 30.81-49.28 | 16.33-28.98   | 5.96-13.24    | 0.30-4.92     |
|        | (40.32 ± 3.74)| (21.99 ± 2.47)| (9.32 ± 1.64) | (1.32 ± 0.84) |
| April (Female) | 30.81-49.28 | 16.66-28.98   | 5.96-13.24    | 0.30-4.92     |
|        | (40.87 ± 3.87)| (22.28 ± 2.57)| (9.33 ± 1.80) | (1.34 ± 0.85) |
| April (Male)  | 30.90-47.74 | 16.33-28.35   | 6.40-11.82    | 0.32-4.27     |
|        | (39.34 ± 3.29)| (21.47 ± 2.20)| (9.30 ± 1.33) | (1.30 ± 0.82) |
| May (all)    | 33.25-53.15  | 17.10-29.55   | 6.35-15.20    | 0.50-4.65     |
|        | (44.10 ± 3.88)| (23.66 ± 2.46)| (10.54 ± 1.34)| (2.27 ± 0.95) |
| May (Female) | 33.25-53.15  | 17.10-29.55   | 6.35-15.20    | 0.50-4.65     |
|        | (44.50 ± 4.30)| (23.86 ± 2.80)| (10.73 ± 1.59)| (2.14 ± 1.02) |
| May (Male)   | 34.25-50.35  | 18.30-28.10   | 7.95-13.45    | 1.00-4.30     |
|        | (43.69 ± 3.38)| (23.45 ± 2.06)| (10.35 ± 1.00)| (2.40 ± 0.87) |
| June (all)   | 33.45-55.20  | 18.00-32.25   | 5.00-12.00    | 0.10-4.40     |
|        | (43.64 ± 3.81)| (24.71 ± 2.80)| (8.42 ± 1.53) | (1.47 ± 1.27) |
| June (Female)| 33.45-55.20  | 18.20-32.25   | 5.00-12.00    | 0.10-4.15     |
|        | (44.03 ± 4.26)| (24.83 ± 3.13)| (8.60 ± 1.68) | (1.34 ± 0.34) |
| June (Male)  | 34.50-52.60  | 18.00-29.00   | 5.35-11.40    | 0.10-4.40     |
|        | (43.30 ± 3.36)| (24.61 ± 2.49)| (8.27 ± 1.38) | (1.58 ± 1.23) |
When this species reached an adult size, *S. luhuanus* stop growing lengthwise, and the outer lip thickens to several millimeters and there is a slight flaring outwards of the lip [5]. According to Caterall and Poiner (1983) [2], juvenile of *S. luhuanus* had an outer lip less than 0.5 mm thicken, and when it reaches an adult stage, its lip was thickened (more than 0.5 mm) and flaring.

![Figure 5](image)

**Figure 5.** Size frequency distribution (SL) of *S. luhuanus* found in Oma coastal waters

Data from Table 1 showed that there was different in shell size between females and males of *S. luhuanus*. The females were longer and wider than males. It means that *S. luhuanus* showed sexual dimorphism. In *S. luhuanus*, adult females are longer than males. Females of the *S. luhuanus* were more globose than males, males were slender than females. Females were larger than males because of the brood sac [12].

Variation on shell length distribution of *S. luhuanus* females and males was shown in Figure 6. This figure showed that the dominant class interval of *S. luhuanus* both for females and males was from 38.70-44.49 mm or in adult size (age of 2*⁺* year) [11]. This figure also shows that the maximum interval class individu was found in a small number only. As it was mention before, this phenomenon occurred because of fishing activities on this species especially in larger shell size.
Figure 6. Size frequency distribution (SL) of females and males of *S. luhuanus* found in Oma coastal waters.

3.3. *The relationship between shell length against shell width and lip thickness*

Shell length, shell width and lip thickness are the main parameter used to determine shell growth of *S. luhuanus*. The relationship between shell length (SL) and shell width (SW) of *S. luhuanus* was given in Figure 7. It can be seen from Figure 7 that shell width increased when shell length increased. *S. luhuanus* showed a straight line, which indicated that shell length was highly associated with shell width.
Lip thickness is one of the main parameters commonly used to estimate the growth of *S. luhuanus*. Uneputty *et al.* (2018) [10] stated that juvenile of *S. luhuanus* had thickened-lip less than 2 mm, and adult size was more than 2 mm. This was supported by O’Dea *et al.* (2014) [6] that lip thickness of juvenile of *S. pugilis* was <1.8 mm, whereas the adult size had thickened lip >1.8 mm.

Plotted of shell length against lip thickness of *S. luhuanus* was shown in Figure 8. It can be seen from Figure 8 that *S. luhuanus* found in our study consists of juvenile and adult size and it was dominated by adult size (52.53%; Table 2). On April and June 2018, the juveniles of *S. luhuanus* were dominated (85.03% and 70.27%, respectively) compared to that of adult size, whereas in May and July 2018, the adult size was dominated (67.77% and 86.47%, respectively) from 122 and 255 individuals *S. luhuanus*. During juvenile growth, the outer lip remains thin until whorl growth ceases, whereupon the outer lip flares and thickened considerably (Figure 2b and 2c). In other word, *S. luhuanus* found in this study was in the development stage of growth.

**Figure 7.** The relationship between shell length and shell width of *S. luhuanus* found in Oma coastal waters.
Figure 8. Plotted shell length against lip thickness of *S. luhuanus* found in Oma coastal waters.

Table 2. Percentage of juvenile and adult of *S. luhuanus* (based on lip thickness) found in Oma coastal water

| Month | Juvenile (< 2 mm) | Adult (> 2 mm) | Total individu |
|-------|------------------|----------------|----------------|
| April | 159 (85.03 %)    | 28 (14.97 %)   | 187            |
| May   | 40 (32.79 %)     | 82 (67.21 %)   | 122            |
| June  | 104 (70.27 %)    | 44 (29.73 %)   | 148            |
| July  | 35 (13.73 %)     | 220 (86.27 %)  | 255            |
| All   | 338 (47.47 %)    | 374 (52.53 %)  | 712            |

4. Conclusion
Shell length of *S. luhuanus* found in this study was varied between 30.81 mm and 55.20 mm; the shell width varied from 16.33 mm to 32.25 mm; its spire height varied between 5.00 mm and 15.20 mm, while the lip thickness varied from 0.10 mm to 5.54 mm. The size distribution of the shell parameter was different between sex and during the sampling periods. *S. luhuanus* showed a sexual dimorphism. The population of *S. luhuanus* was dominated by 38.70-47.39 mm length, which was an adult size. It seems that the increasing of shell length followed by increasing of shell width. Juveniles of *S. luhuanus* were dominated in April and June sampling, while matures size was on May and July sampling.

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