Population dynamics of *Strombus luhuanus*, Linneaus 1758 from Oma coastal waters, Central Maluku, Eastern Indonesia

S Haumahu and P A Uneputty  
Fisheries and Marine Science Faculty, Pattimura University, Ambon-Indonesia

*E-mail: shaumahu2@gmail.com*

**Abstract.** *Strombus luhuanus* (strawberry conch), Linneaus 1758 is a marine mesogastropod belongs to Strombidae family. *S. luhuanus* is locally consumed by coastal communities in Maluku province to fulfill their protein needed, which will decreasing the stock in natural environment. The biological study including population dynamics needed to maintain *S. luhuanus* population. The research was conducted in Oma coastal water, Central Maluku, Eastern Indonesia during January to December 2019. The objectives of this research were to study the aspect of population dynamics of *S. luhuanus* such as asymptotic length (*L*∞), growth coefficient (K), natural mortality (Z), exploitation rate (E) and recruitment. A total of 1823 individual of *S. luhuanus* found in this study which consisted of 831 individual of males and 992 individual of females population. Shell size of *S. luhuanus* varied monthly. The result showed that in general, the male population showed five cohort, while the female showed six cohort. *L*∞ = 63.40 mm, K = 0.65 for females population; whilst for the males population, *L*∞ = 69.80 and K = 0.5. Total mortality (Z) for both population were Z = 3.03 and Z = 4.32, respectively. Exploitation rate of *S. luhuanus* in this study area showed that the population was overexploited (E = 0.64 and E = 0.79 for females and males population, respectively).

1. **Introduction**

*Strombus luhuanus* (strawberry conch) Linneaus, 1758 is a marine mesogastropod belongs to Strombidae family. *S. luhuanus* is tropicopolitan gastropod found widely in tropic and sub tropic area. This gastropod generally found in intertidal to shallow subtidal area in west Indo-Pacific [1].

*S. luhuanus* is locally consumed by coastal communities in Maluku Province especially people in Oma village for their daily protein. Intensive collecting activities can cause decreasing on shell size as well as its number of individual (population) in marine environment. Therefore, studies on biological aspects including population dynamic aspect of target species are very important to maintain the stock of the species in natural environment.

Some study have done on *Strombus luhuanus*. Reproductive biology of the gastropod *Strombus luhuanus* (Strombidae) briefly noted [2]. The behaviors of locomotion, feeding, righting and escape of *S. luhuanus* was described [3]. Distribution and growth of the gastropod *Strombus luhuanus* at Shirahama, Japan was also noted [1]. Some information on *S. luhuanus* in Maluku coastal waters also described [4, 5, 6, 7]. The information on population aspects of this species have not studied extensively. This article will focus on population dynamics aspect of *S. luhuanus*. The objectives of the study were to analyze the abundances, size frequency distribution, the number of cohort performed, asymptotic length (*L*∞), VBGF growth coefficient (K), mortality (including natural, fishing, total mortality and exploitation rate, E) and recruitment pattern.
2. Materials and Method

2.1. Field work
The study was carried out in Oma coastal water (128°23′30″ - 128°25′50″E and 03°37′25″ - 03°37′50″S), Central Maluku, Eastern Indonesia (Figure 1) from January to December 2019. The substrates found in intertidal zone consisting of a boulder, pebble, dead coral, coral rubble, and coarse sand.

![Map of sampling site](image1)

**Figure 1.** Map of sampling site

Sampling was conducted during low tide in the day time. Specimen of *S. luhuanus* collected randomly in the area of intertidal zone without replacement [8]. Shell length of the specimen was measured using digital Vernier caliper with an accuracy of 0.01 mm. Shell length is a distance between the apex and the tip of siphonal notch along the coiling axis (Figure 2). 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 [2].

![Measurement of shell length](image2)

**Figure 2.** Measurement of shell length (SL)
2.2. Data Analysis

From the data collected, the length frequency distribution was performed. All the data were estimated by means of ELEFAN-I incorporated in the FISAT software package. The asymptotic length ($L_\infty$) value was estimated using modified Powell-Wetherall plot, which was then used as seed value in ELEFAN-I analysis to assess a reliable estimate of the growth coefficient $K$ and recruitment pattern. The Bhattacharya-method of ELEFAN I program was used to visualize the different cohort of the sample. For calculating total mortality ($Z$), the length converted catch curve was applied using the estimated growth parameter. Natural mortality ($M$), fishing mortality ($F$) and exploitation rate ($E$) also calculated using the growth parameter. The value of $E$ can determine the state of fishing activity, in which $E < 0.5$ means the stock is underexploited; $E > 0.5$ which means the stock is overexploited. All the data were calculated using FISAT program [9]

3. Result and Discussion

3.1. Abundance

The total of 1823 individual of *S. luhuanus* were collected during this study periods, in which the males population were 831 individual (45.58%) and the females were 992 individual (54.42%). The abundances of male population were lower than the female population. This result showed that the females were dominant compared to the males one. This was because of the differences of growth pattern and migration of this conch [2].

The abundances of *S. luhuanus* varied monthly (Figure 3). During March to May 2019, the abundances of *S. luhuanus* were higher than other sampling periods for both males and females population. The lowest abundances found on July 2019. The abundances were slightly increasing on August and September, and decreased again on October to December 2019. The lowest abundances in July, October to December due to the intensive collecting activities on several month before.

![Figure 3](image_url)  
*Figure 3. The abundance of *S. luhuanus* from the study area*

3.2. Size frequency distribution

The shell length of *S. luhuanus* found in this study varied between 28.5 mm and 57.75 mm. Shell length of male population was slightly lower than that of females one, which was varied from 28.5 mm to 55.75 mm, while the shell length of female population was from 29.15 mm to 57.75 mm (Figure 4).
Figure 4. Size-frequency distribution of *S. luhuanus* found in the study area
Shell length of *S. luhuanus* found in the previous study [6, 7] varied from 30.27-56.00 mm and 29.64-55.88 mm, respectively. The minimum shell length of *S. luhuanus* in this study was smaller than that of the previous study, whereas the maximum shell length was slightly higher. 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. The slender males could be an ecological adaptation for agility to increase reproductive success [10]. Some studies have been done on Strombidae and showed that males was smaller than females [11, 12, 13].

The shell length of this conch varied monthly (Figure 4). Pourtier (1998) [14] stated that maximum shell length of *S. luhuanus* is 8 cm, but generally found to 5 cm. The shell length of *S. luhuanus* found in this study consisted of small size to large size. Wada *et al* (1983) [1] stated that large conch was in shell length more than 40 mm, while small conch was in 30-40 mm in shell length. Uneputty *et al* (2019) [6] found *S. luhuanus* from the same area of study consisted of juvenile and adult population. Juvenile population was less than 30 mm in shell length, while adult population was more than 30 mm in shell length. The dominant population found in this study area was in class interval of 41-45 mm in shell length, which meant the dominant population was in the adult size. Shell length of *S. luhuanus* from 35-60 mm was belonged to adult individual and having thickness outer lip [15]. People in this study area usually collect adult population and large shell size for their protein needed.

3.3. Population structure (cohort)

The cohort can be used to determine population structure of *S. luhuanus* inhabit Oma coastal waters, which was analyzed using Bhattacharya method from FISAT software. Frequency of occurrence and mid-class length from both two populations (males and females) used to analyze this cohort. The computed growth curve using these parameters over the restructured length distribution showed in Figure 5. It can be seen from Figure 5, there were five cohort performed in male population, whilst six cohort found in female population. The first and second cohort were found in shell length <30 mm. The third cohort found in shell length between 30-40 mm, the fourth cohort found between 40 mm and 50 mm in shell length, while the fifth and the sixth cohort were found in shell length >50 mm. This data showed that the dominant population of *S. luhuanus* was on cohort 3 and 4 for both populations. Wada *et al* (1983) [1] stated that strawberry conch with shell length around 20 mm can be regarded as 0+ year group, conch with 30-40 mm in shell length was at the age of 1+ year group, and conch with shell length from 35-35 mm was 2+ year group. This conch can reach more than 3 years in lifespan.

![Figure 5. Von Bertalanfy growth curves of *S. luhuanus* male and female in the study area](image_url)
3.4. Growth
The von Bertalanffy growth model was a suitable model for describing the growth of mollusks [16]. The asymptotic length (L∞) for these both populations were 69.80 mm (males) and 63.40 mm (females), respectively (Table 1). The maximum shell length found in this study was 55.75 mm for male population and 57.30 mm for the females, respectively. Based on L∞ value found in this study, male population reach maximum shell length higher than female population. As it previously stated that maximum shell length of S. luhuanus is 80 mm [11]. Asymptotic length of S. luhuanus was lower than that of Strombus gigas (251 mm) [16]. This difference was because of the different type of species, the ecosystem investigated and the response of species to environmental gradient. S. gigas is large, commercially important gastropod and grow to 23 cm in shell length [17]. The growth coefficient (K) for S. luhuanus males and females were 0.5 year⁻¹ and 0.65 year⁻¹, respectively. This value showed that female population grow faster than the male population. There was not any information on growth coefficient of this species published yet.

| Population parameters                  | Male population | Female population |
|----------------------------------------|-----------------|-------------------|
| Asymptotic length (L∞), mm             | 69.80           | 63.40             |
| Growth coefficient (K), year⁻¹          | 0.5             | 0.65              |
| Natural mortality (M), year⁻¹           | 0.90            | 1.69              |
| Fishing mortality (F), year⁻¹           | 3.42            | 1.94              |
| Total Mortality (Z), year⁻¹             | 4.32            | 3.03              |
| Exploitation rate (E), year⁻¹           | 0.79            | 0.64              |

3.5. Mortality
The natural mortality for both populations (males and females) were 0.90 year⁻¹ and 1.94 year⁻¹, respectively based on length converted catch curve (Table 1 and Figure 6). This value indicated that natural mortality was lower than that of fishing mortality. The higher value of fishing mortality indicated that there was the strong fishing impact, in which could be seen in the value of exploitation rate (E).

![Figure 6. Length converted catch curves for S. luhuanus in the study area](image)
The exploitation rate (E) of *S. luhuanus* from this study area was higher than 0.5 (Table 1). It means that the population is overexploited. The heavy fishing mortality was due to heavy collecting activities of *S. luhuanus* population in this study area. During the study periods, the number of people who collected this gastropod were approximately 10-15 people. One can collect 50-100 individual of this gastropod. Therefore, a good management strategy should be applied in this study area in order to maintain this *Strombus* population in their natural environment.

3.6. Recruitment pattern
Recruitment can be determined from the size frequency distribution histogram. The recruitment pattern of *S. luhuanus* in this study area was continuous during 12-month study period with two major peaks was observed during January – March 2019 and June – August 2019 (Figure 7). The continuous recruitment pattern of *S. luhuanus* with two major peaks because of the spawning events took place in February 2019 and July 2019. Kuwamura et al [2] found the spawning season of *S. luhuanus* in Shiharama, Japan on March to August with the peak season on June. The differences of spawning season due to different environmental conditions, season, and geographical area.

![Figure 7. Recruitment pattern of *S. luhuanus* in the study area](image)

4. Conclusion
The 1823 individual of *Strombus luhuanus* found in this study area, and dominated by female population. The shell length of *S. luhuanus* found in this study varied between 28.5 mm and 57.75 mm, in which shell length of females was longer than the males. Five cohort found in male population, while six cohort found in the females. The asymptotic length (L∞) for both males and females were 69.80 mm and 63.40 mm, respectively. The growth coefficient (K) of the males was lower than the females. Fishing mortality and exploitation rate indicated that *S. luhuanus* population in overexploitation. Recruitment pattern of *S. luhuanus* was continuous during 12 month sampling.

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