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Some growth characteristics of yellow-mouth turban shell (*Turbo chrysostomus*) in Ly Son Islands - Quang Ngai Province

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ABSTRACT

Focusing on the species *Turbo chrysostomus*, the study examined aspects of distribution, growth characteristics and resource management strategies. *Turbo chrysostomus* mainly inhabits low water areas to coral reefs with a depth of 8 meters. The average Turban Shell height is 47.51 mm. The theoretical maximum size is 76.9 mm with growth factor $K = 1.17$, and the monthly growth rate in the first year is 5.36 mm. The correlation between the height (H) and weight (Wm) of the snail is $H = -0.001 * Wm + 0.8822$. Notably, its growth pattern is uneven, with height increasing faster than weight. Worryingly, wild mussel populations are showing signs of decline, requiring resource management measures. Proposed solutions include eliminating the capture of small snails and avoiding development in key breeding areas, particularly Chua Hang and Hang Cau, to ensure the sustainability of the snail resource into the future.

Keywords: Yellow mouth Turban, coral reef, growth rate, Ly Son, *Turbo chrysostomus*.

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INTRODUCTION

“Ốc Cừ” also known as the Yellow Mouth Turban Shell or Gold-Mouth Turban Shell, is a snail species commonly harvested for food in sea areas with coral reefs and dead coral tidal flats. Turban Shell is the common name for snails of the *Turbo* genus, which belong to the Turbinidae family. Three species recorded at Ly Son include *Turbo chrysostomus*, *T. bruneus*, and *T. petholatus* (Research data of the project “Investigate, evaluate resources and propose solutions to protect, develop and sustainably exploit Turban shell (*Turbo chrysostomus*) in Ly Son waters” [1–3]. Among them, *Turbo chrysostomus* is the most common, exhibiting high density on the coral reefs and tidal zones of Ly Son islands (Research data of the project “Investigate, evaluate resources and propose solutions to protect, develop and sustainably exploit Turban shell (*Turbo chrysostomus*) in Ly Son waters”).

Worldwide, Turban shell is found in coastal waters of the Indo-Pacific region including the coastal waters of the Indian Ocean (Kenya, Seychelles, Chagos, Andaman and Nicobar Islands), Southeast Asia (Malaysia, Indonesia, Thailand and the Philippines) and the Fijian Islands on the South Sands [4]. The Turban shell is also found in coastal waters of the Ryukyu Islands, Japan [5], and in the waters of Northern Melanesia to Southern New Caledonia [6, 7]. Turban shell is usually nocturnal on coral reef substrates and is typically found at depths from the intertidal zone to 4 m below the intertidal zone [8]. Naung Naung Oo et al., (2019) [9], when studying the Turban snails in Andrew Bay, Myanmar, found that the Turban snails *Turbo chrysostomus* were distributed from the intertidal zone to a water depth of about 20 m.

With its wide distribution from shallow tidal flats to deep waters of coral reefs, accessing this resource is relatively easy for the local community. Consequently, *Turbo chrysostomus* is primarily harvested to meet daily food needs and to serve tourists visiting and relaxing on the island. Coral reefs and tidal areas provide essential habitats throughout the life cycle of Turban Shells. Effective conservation of the

coral reef and tidal flat ecosystems around Ly Son islands will ensure the sustainability of these aquatic resources and bring economic benefits to the local community.

Research activities on biodiversity and assessment of the current status of Turban Shell density and habitat characteristics will provide essential scientific information for developing management and conservation plans for this resource in Ly Son waters. This report presents the results of biological research on Turban Shell growth, serving as a basis for proposing solutions to protect, develop, and sustainably exploit *Turbo chrysostomus* in Ly Son waters.

MATERIALS AND METHODS

The survey was conducted using the rapid assessment method with community participation to collect data on the exploitation and use of Turban shell in Ly Son and FAO Fisheries Survey Methodology (2010) [10], including exploited objects, fishing gear and fishing season, number of boats, number of people/boat, exploited output/boat/pot, total output (kg), selling price, cost, impacts and trends of resource change, information on seed source grounds, seed appearance season. The consultation period was carried out in June 2023. We invited representatives in charge of fisheries, experienced fishermen from various types of snail exploitation, and middleman occupations to participate in providing information. The total number of consultants was 37 people and 37 survey forms were also collected.

Data on the distribution of Turban shell were collected at 8 intertidal sites and 10 coral reef sites in June 2023. A hypothetical transect was placed perpendicular to the shore. Turban shell density data were collected in 25 m² (5 × 5 m) cells along the transect with corresponding depths of 0.5, 1, 1.5, 2 m, respectively. The number of data cells depends on the slope and width of the intertidal flat, but a minimum of 5 cells is required at a survey location. For coral reef sites, the assessor will count the number of Turban shell appearing in 3 data cells 25 m²

(5 × 5 m) at each depth zone when there is a change of 1 m depth to 12 m water depth. After being processed and calculated, the data will be grouped into zones as follows: 1–2 m, 3–4 m, 5–6 m, 7–8 m, 9–10 m, 11–12 m.

The growth characteristics of the Turban Shell were studied using the method described by King (2001) [11]. Samples were collected monthly, was purchased from the middleman, with a minimum of 30 individuals per month. The Turban Shell samples were preserved in 96% alcohol and then transported to the laboratory at the Institute of Oceanography for biological growth analysis.

Growth characteristics include:

The correlation of dimensions is determined by linear regression method.

Size-weight correlation is determined based on measurements of size and weight to determine the correlation of snail according to the Beverton - Holt's equation:

$$W = a \times L^b \quad [12]$$

in which: W : whole body weight (g); L : size of height (mm); a, b : are the coefficients that need to be determined, calculated according to the experimental regression calculation method.

The parameters of the Von Betalanffy equation of natural snails are determined by the high frequency method [12]:

$$H_t = H_{\infty} * [1 - \exp(-k(t - t_0))]$$

in which: H_t : height of age t ; H_{∞} : theoretical maximum height; t_0 : larval development time.

RESULTS AND DISCUSSION

Distribution characteristics of Turban shells

Based on the data on the distribution of conch combined with the coral reef distribution diagram and the topographic map of the reef area, it is possible to preliminarily outline the distribution area of Turban shell in the Ly Son sea area (Fig. 1). It can be roughly calculated as follows: For example, in the area of 1–2 m depth, the average Turban shell density is 3.52 inds./100 m² with a converted mass of 23.35 g/individual

on an area of 205 ha, the estimated reserve is 1,684.93 tons. The total immediate reserve for the whole area is 3,974.34 tons. With an average exploitation of 1 ton/day, this reserve is enough for about 9.13 years of exploitation (Table 1).

Results from consultation sources of fishermen directly exploiting and from the middleman of Turban shells show that the time of appearance of small-sized Turban shell is often concentrated in 2 periods in a year, the first period is from December to February of the following year and the second period is from July to September. During these two periods, fishermen often encounter small-sized Turban shells (like melon seeds) in the reefs around the island. The distribution area of the source of Cu snails is mostly on the reefs around the island from the wave edges to deeper with a depth of about 7–8 m. This also suggests that the distribution area of Turban shell is also a breeding ground to supplement the population.

Survey results combined with community consultation show that Turban Shells are mainly distributed at depths of 1–6 meters, with the highest concentration at 3–4 meters on the coral reef flat and reef slope, where the bottom has many caves (5.36 ± 6.57 inds./100 m²), gradually decreasing towards the base of the reef (Figure 1). At a depth of 1-2m, the density of Turban shell reached 3.52 inds./100 m². At a depth of 5–6 m, the density of Turban shell reach 3.26 inds./100 m² and at 7–8 m it was 2.61 inds./100 m² respectively. At depths of 9–11 meters at the base of the reef, snails are rarely found (0.34 inds/100 m²). The bottom of the intertidal zone where Turban shell is distributed is dead coral, coral rubble, grass and seaweed with not too high coverage (coverage fluctuates between 10–40%). Notably, individuals smaller than 15 mm in height were observed in the intertidal survey samples at Chua Hang (1 individual), Hang Cau (1 individual), and Ran go An Vinh. Snails smaller than 30 mm in height were found at most survey sites, both intertidal and coral reefs. This suggests that the Ly Son coral reef area is not only where adult snails are distributed but also serves as a breeding nursery for snails.

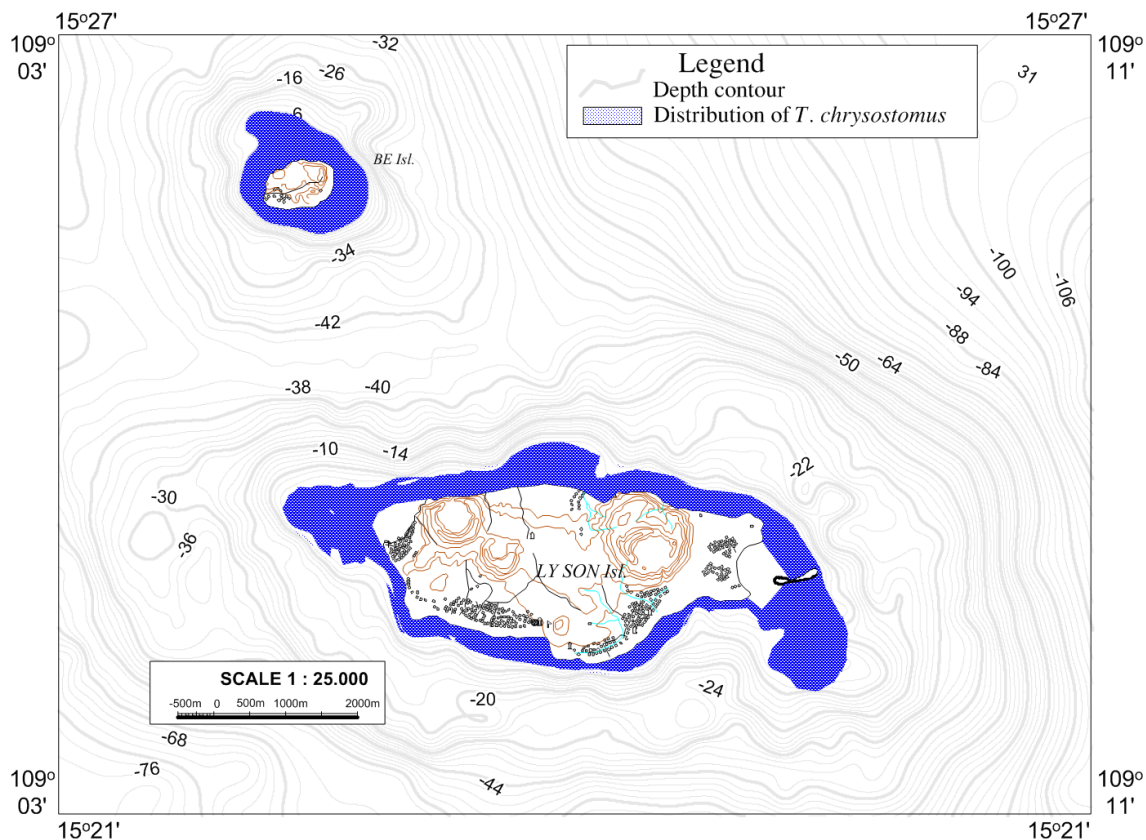


Figure 1. Diagram of *Turbo chrysostomus* snail distribution area

Table 1. Instantaneous reserves of conch in Ly Son sea area

Parameter	1–2 m depth	3–4 m depth	5–6 m depth	7–8 m depth	9–11 m depth	Total
Density (inds./100 m ²)	3.52	5.36	3.26	2.61	0.34	
Hieght (mm)	43.23	38.08	39.14	43.84	50.50	
Conversion mass (Wtt (g))	23.35	16.45	17.74	24.28	35.90	
Area (ha)	205	179.80	103.90	15.07	6.35	510.12
Immediate reserve (tons)	1,684.34	1,584.88	600.96	95.49	7.75	3,974.34

Exploitation size

The fishing season is year-round, with an average output of about 1,190 tons/day. However the main fishing season is from April to August every year when the weather conditions are favorable for fishermen to fish. In which, the fishing season by air diving mainly takes place from April to December, while diving and wading takes place almost all year round except during storms and holidays.

A total of 323 individuals were collected from February 2023 to October 2023 in the Ly

Son region (collected from middleman). The parameters of the sample set, listed in Figure 2, show that the average Turban Shell height is 47.51 mm, with the 46–50 mm group accounting for 30% of the total number of individuals. The second most common group is 41–45 mm, comprising 24.15% of the total. The largest individual measured 73 mm, while the smallest was 33 mm. The average catch size fluctuated slightly over the months, ranging from 44 to 50.80 mm, with a slight increase from February to June and a tendency to decrease from July to October 2023 (Fig. 3).

Size groups larger than 60 mm were present in February, April, May, June, and July, with the size group above 70 mm appearing in June.

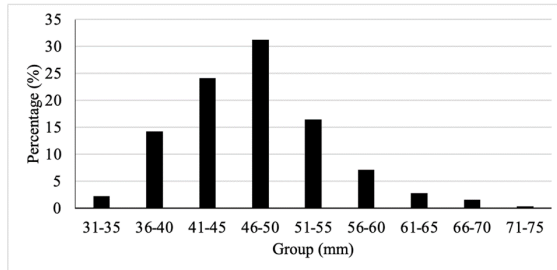


Figure 2. Catching size structure ($n = 313$)

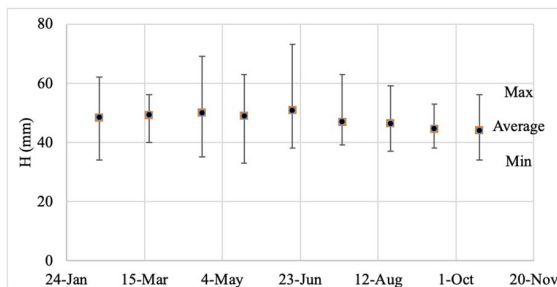


Figure 3. Mean catching size ($n = 313$)

The correlation of dimensions

The correlation of size dimensions shown in Figure 4 indicates that, unlike other species, the height of the Turban Shell increases at a

faster rate than its width (the R/H ratio approaches 1 for smaller size groups). This means that as the Turban Shell grows larger, its height increases more rapidly than its width.

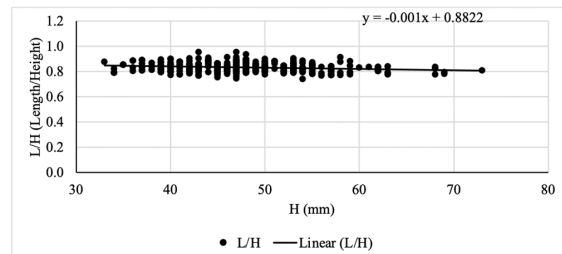


Figure 4. Correlation of width/height ratio (R/H) and height of Turban shell

Size-weight correlation

The correlation between the height and weight of the snail is shown in Figure 5. A b -value less than 3 indicates that the snail does not exhibit isometric growth; its height increases at a faster rate than its weight. According to Cone (1989) [13], when the growth coefficient value $b = 3$, body size and weight change at the same ratio throughout the growth process (co-growth). When $b < 3$, organisms increase in mass at a slower rate than they increase in length, and when $b > 3$, organisms increase in mass faster than they increase in height.

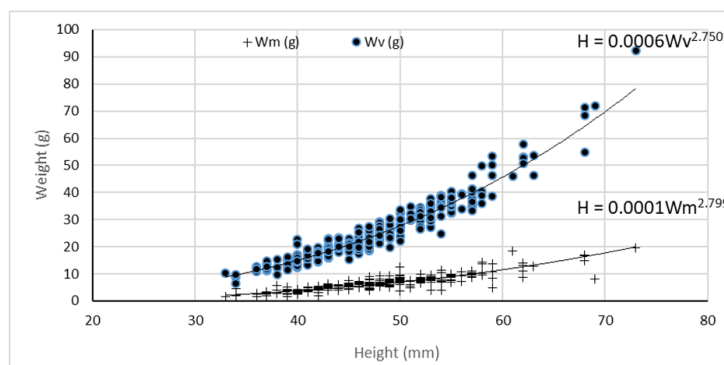


Figure 5. Height - weight relationship of Turban shell

The parameters of the Von Betalanffy equation

Calculating the parameters of the von Bertalanffy's growth equation based on height

frequency, yields the results shown in Figure 6. One-month-old snails reach a height of 7.14 mm, and after 6 months, they reach 38.04 mm. By 8 months, snails begin reproducing, and at 1 year,

they reach 53.03 mm, eventually attaining their maximum size after about 4 years. The average growth rate is 5.20 mm per month, and as the snails grow larger, their growth rate slows.

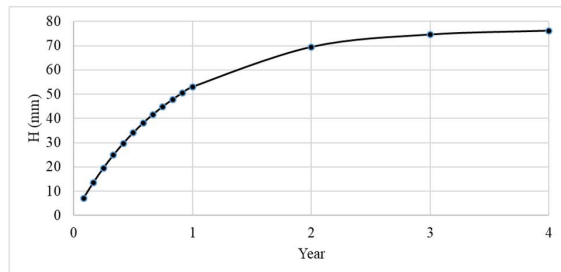


Figure 6. Size of theoretical Turban shell at different ages

Comparison with other studies presented reveals that the average growth rate of Turban Shells surpasses that of *Solen thachi* (misidentified, correct name is *Solen vigina*) snails (5.2 mm/month) [14] and is 2.144 times higher than the average growth rate of Abalone *Haliotis diversicolor* (2.5 mm/month) [15] and Red-lip Turban shell *Strombus luhuanus* [16].

Propose some measures to manage resources

The aforementioned research findings serve as the scientific foundation for proposing measures to safeguard Turban shell resources. Through exploration, indications of a decline in natural snail resources have become evident. Therefore, it is imperative to implement resource management strategies, starting with the proposition of sustainable exploitation methods.

Based on the research outcomes, it is advisable to refrain from capturing small snails before they have had the chance to engage in reproduction, allowing for population regeneration in the wild. Furthermore, exploitation in tidal areas, particularly in Chua Hang and Hang Cau, should be avoided to safeguard breeding grounds and ensure the replenishment of Turban shell resources in the future. Results from consultation data on the time of snail emergence suggest that exploitation should be avoided in May-July and October-December to allow Turban shells to participate in reproduction and develop the population.

CONCLUSION

The Turban Shell species *Turbo chrysostomus* primarily inhabits the low tidal zone up to a water depth of 8 meters within the coral reef ecosystem. With a theoretical maximum size of 76.9 mm, these snails exhibit a monthly growth rate of 5.36 mm during their first year. Notably, Turban shells display non-uniform growth patterns, with their height increasing faster than their body weight. However, despite their resilience, Turban shell resources in the wild have shown concerning signs of decline. In response, effective resource management strategies are crucial, beginning with the formulation of sustainable exploitation practices. Specifically, it is recommended to refrain from capturing small-sized snails and to avoid exploitation in tidal areas, particularly in sensitive breeding grounds like Chua Hang and Hang Cau, to ensure the future supplementation of Turban shell resources. Second is to limit exploitation during the breeding season, especially in May-July and October-December so that snails can participate in reproduction to restore resources.

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