THE RELATIONSHIPS BETWEEN SHELL LENGTH AND OTHER LINEAR MEASUREMENTS OF DOG CONCH (*Laevistrombus canarium*) COLLECTED FROM THE SUBTIDAL ZONE OF INFANTA, PANGASINAN, PHILIPPINES: A PRELIMINARY ASSESSMENT

Abstract

The dog conch (*L. canarium*), known locally as "pingo" is an important resource harvested in the town of Infanta, Pangasinan. The species is targeted for its meat and shell. The species inhabits seagrass beds with diverse substrates. To date, its fishery remained subsistence or artisanal worldwide. The aim of the study is to provide baseline information on the relationships between shell length and other linear measurements of the species that can be used for its future management and aquaculture. Based on the result, SL and other linear measurements such as BW, AL, SW, SD and LT showed are related allometrically. These relationships can be expressed as: $BW = 6.83\ SL^{0.67}$; $AL = 4.38\ SL^{0.72}$; $SW = 8.50\ SL^{0.53}$; $SD = 5.42\ SL^{0.41}$; and $LT = 1.39\ SL^{0.09}$. These equations can be used to predict the values of BW, AL, SW, SD and LT with a known SL and differentiate local population from those in other areas.

Keywords: correlation coefficient, marine snail, seagrass beds, slope, vernier caliper

Introduction

The marine snail, dog conch (*L. canarium*) is a medium-size edible fishery resource that can be found in the coastal waters of Infanta, Pangasinan. The resource is known as "pingo" in the locality and commonly harvested during lean periods. The species is highly associated with seagrasses located in muddy sand bottom, coral sand bottom and subtidal zone [1]. High preferences were observed in areas that is dominated by *Halophila* species while areas with dense *Enhalus acoroides* were least preferred [2]. It feeds on plankton, filamentous algae, detritus, macroalgae fragments and seagrass [3, 4]. An experiment conducted showed that higher food consumption and assimilation can be attained at 26ºC [5].

The species is considered economically important, which is harvested by many fishing communities across the Indo-Pacific region for its meat as staple food and shell, which has also considerable ornamental value [1, 5, 6]. The dog conch is commonly harvested by hand and/or with the use of labor-saving equipment such as dredges, motorized boats and diving gears [7]. However, it was reported that the population of dog conch is declining as a result of heavy fishing pressure and environmental degradation [6, 8]. Recruitment is still solely dependent on natural replenishment and technologies for its production in captivity have yet to be developed [8]. Because of the preponderant role of dog conch in the seagrass ecosystem, resource surveys and management have been taken into consideration [8]

To date, the fishery of dog conch remained subsistence or artisanal. In the Philippines, it is considered as an economically important snail species that provides protein for many coastal communities [9]. However, there is still little information on the quantity harvested in its geographic distribution. Moreover, the species is not extensively studied as compared to other widely known conch species [5]. However, because of its commercial value many aspects of its biology have been assessed, including population dynamics, reproductive cycle, life history, food preferences, habitat and environmental effects, as well as its potential for aquaculture [1, 2, 8, 10, 11].

In fishery biology, determining the mathematical relationship between linear measurements is an important aspect, particularly in studying taxonomic and sexual differences [12]. Moreover, these are useful tools in fishery resource assessment and management [13]. However, there is still limited undertakings conducted focusing on the shell morphometrics and their relationships in marine snails. The assessment of the relationship between the morphometric measurements of the dog conch in Infanta, Pangasinan will provide salient information that could be used in its future management and aquaculture.

In studying dog conch, shell length, body whorl length, shell width, shell depth, shell lip thickness, aperture length, animal weight and shell weight are among important shell parameters that were measured and analyzed [1]. Shell length alone can be used as predictor of morphometric traits [14]. Changes in the shell morphometry of marine snails have been associated with various environmental factors, such as wave exposure, food quality and quantity, intraspecific competition, predation, life stages, temperature and salinity [15-18].

Methodology

Collection of Samples

Collection of samples was conducted in the subtidal zone of Cato, Infanta, Pangasinan with the aid of a commissioned fisher (skin diver). From the catch of the fisher, a total of 100 pieces of morphologically identified *L. canarium* were randomly selected. The snails were cleaned (by removing epiphytes and small barnacles) prior to the measurement of target parameters.

Linear Measurement

A total of 6 linear measurements of the shell (Figure 1) were taken using a digital vernier caliper with an accuracy of 0.01 mm, following the published material of Cob et al. [1]. These measurements include shell length, body whorl length, aperture length, shell width, shell depth, and shell lip thickness (Table 1).

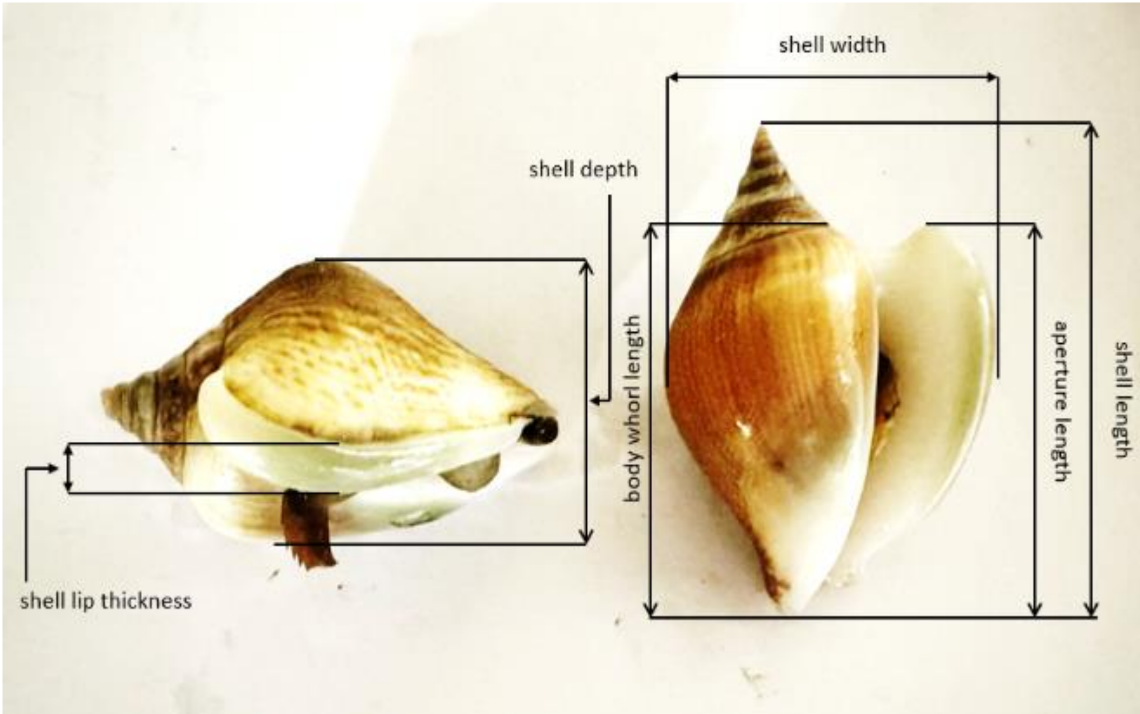

Figure 1. Morphometric measurements of dog conch shell

Table 1. Description of the linear measurements of the shell considered in this study

Morphometric Measurement	Description
Shell length (SL)	The distance between the apex and the anterior portion of the shell; the entire length of the shell
Body whorl length (BW)	The measurement of the mid-lateral region; the distance between the anterior end and the border of the body whorl and spire.
Aperture length (AL)	The length of the shell's single opening
Shell width (SW)	The widest distance across the shell, which includes its aperture
Shell depth (SD)	The distance between the top and bottom of the shell's largest whorl
Shell lip thickness (LT)	The measurement of the mid-lateral region on the lip side of the shell

Assessment of Degree of Association Between Shell Length and other Linear Measurements

The degree of association between the shell length and other linear measurements such as body whorl length (BW), aperture length (AL), shell width (SW), shell depth (SD) and shell lip thickness was ascertained based on the value of correlation coefficient (r) following the scale and interpretation of Reyes et al. [19].

Estimation of the Relationship Between Shell Length and other Morphometric Measurements

The relationship of the shell length with other linear measurements was expressed using the equation adopted from Reyes at al. [19]:

$$X = e^{a} (SL^{b})$$

where X is the other linear measurement (BW, AL, SW, SD, and LT) expressed in mm, SL is the shell length expressed also in mm, a is the intercept and b is the slope or exponent. The statistical significance of the regression was also presented.

Results and Discussion

The minimum, maximum, mean and standard deviation of the shell's linear measurements are presented in Table 2. The SL of the samples is ranging from 35.20 to 54.90 mm, with a mean of 45.11 (±3.74) mm. The recorded BW ranged from 29.80 to 44.90 mm and has a mean of 37.17 (±2.83) mm. In terms of AL, measurements were fluctuated from 29.20 to 45.40 mm, with 36.70 (±3.21) mm as the most frequent. With regard to SW, the obtained values varied from 25.00 to 38.70 mm, with 32.27 (±2.52) mm as the dominant measurement. The recorded SD were in the range of 18.00 to 30.80 mm, with a common value of 23.92 (±2.19) mm. Meanwhile, LT measurements ranged from 4.00 to 7.40 mm and having a mean value of 5.50 (±0.67) mm.

The SL is considered as the most commonly used indicator to describe snail growth as it is a more consistent variable [20]. Based on the recorded SL, the collected individuals are already in the adult stage. According to Man in't Veld & De Turck [21], the SL of adult specimens is ranged from 29.00-71.00 mm. In the study of Ramses et al. [6], the shell length of dog conch collected from the waters of Kota Batam, Indonesia is within the range of 48.35-78.82 mm and has a mean of 64.29 mm. Comparing the shell length of individuals from this study to their finding, it can be noted that adult dog conch from the subtidal zone of Infanta, Pangasinan is smaller. The obtained mean SL is concordant with the report of Cob et al. [1]. Information on the frequent values of other morphometric measurements of dog conch shell is still limited. However, the obtained values are almost similar with the report of Cob et al. [1]. Relative to this, they have indicated that no significant differences can be observed between male and female individuals except for shell depth. In accordance with their finding, males have deeper shell compared with females. In *Lobatus gigas*, LT have been identified as a more reliable proxy indicator of reproductive maturity [22]. The mean LT obtained in the present study is greater than those observed by Cob et al. [1] in Merambong Shoal, Malaysia and in some *Strombus* species collected from different habitats in Surigao del Sur, Philippines [23]. According to Ruaza & Dy [23], variation in lip thickness can be linked to habitat type, fishing pressure, wave action, current strength and predation.

Table 2. The minimum, maximum, mean and standard deviation of the shell's linear measurements

Morphometric Measurement	N	Minimum	Maximum	Mean	Std. Deviation
SL	100	35.20	54.90	45.11	3.74
BW	100	29.80	44.90	37.17	2.83
AL	100	29.20	45.40	36.70	3.21
SW	100	25.00	38.70	32.27	2.52
SD	100	18.00	30.80	23.92	2.19
LT	100	4.00	7.40	5.50	0.67

Table 3 provides the degree of association of the paired variables subjected to correlation analysis. Highest r value was recorded in the pair of SL-BW (0.89), followed SL-AL (0.84), SL-SW (0.78) and SL-SD (0.70). Meanwhile, the lowest value was recorded in the pair of SL-LT. These paired variables are all positively associated. Based on these results, the degree of association of SL-BW and SL-AL is regarded as "very strong" while SL-SW and SL-SD can be interpreted as "strong". In terms of SL-LT, the degree of association is only "moderate".

Table 3. The degree of association of paired variables

Paired Variables	***r value***	***Sign***	***Degree of Association***
SL – BW	0.89	+	Very strong
SL – AL	0.84	+	Very strong
SL – SW	0.78	+	Strong
SL – SD	0.70	+	Strong
SL – LT	0.51	+	Moderate

The relationship between shell length and other morphometric measurements is shown in Table 4. Based on the result of analysis, the relationships of SL to BW, AL, SW, SD and LT are linear, suggesting that as SL increases there is also a corresponding increase in other shell parameters. However, the contribution of SL varied depending on the type of shell parameter as indicated by the obtained "b" values. Moreover, the rate of increase among these parameters is less than the increase in SL since the "b" values are less than 1.0. This result may suggest that the shell of dog conch become more elongated with age. Similar findings have been reported in some parameters of *Monodonta dama* [24]. The highest value of the coefficient of determination (r^2) was obtained in the pair of SL-BW (0.79), followed by SL-AL (0.70), SL-SW (0.61), SL-SD (0.49) and SL-LT (0.26). These values indicate that 26.0 to 79.0% of the total variations in other linear measurements can be explained by the equation. Moreover, it was found that all established equations for SL and other shell parameters showed high level of significance ($p<0.01$) except for SL-LT ($p>0.05$), suggesting that these equations could be used to predict BW, AL, SW and SD provided that SL value is available. In gastropods, the relationship between various body parts was linked to genetic and environmental factors [25].

Table 4. The established relationship equation between shell length and other linear measurements

Paired variables	***a***	***b***	***r^2***	**Generated Relationship Equation**	***p value***
SL – BW	6.83	0.67	0.79	$BW = 6.83\ SL^{0.67}$	<0.01
SL – AL	4.38	0.72	0.70	$AL = 4.38\ SL^{0.72}$	<0.01
SL – SW	8.50	0.53	0.61	$SW = 8.50\ SL^{0.53}$	<0.01
SL – SD	5.42	0.41	0.49	$SD = 5.42\ SL^{0.41}$	<0.01
SL – LT	1.39	0.09	0.26	$LT = 1.39\ SL^{0.09}$	>0.05

Morphometric studies have been implemented in marine snails or gastropods because of their diversity and abundance. Analysis of shell morphometry has been regarded as a vital tool in taxonomic classification [26]. It is widely used to directly quantify, analyze and describe variations among animals, particularly finfish and shellfish populations [27, 28]. Specifically, it can be used to identify different species and their biological characteristics such as growth pattern, overall health, reproductive stages and feeding strategies, as well as the condition of their habitats [29]. Hence, it is indispensable to use standard measures to gain reliable results when comparing populations [19].

Conclusion

The marine snail, *L. canarium* has not been widely studied. The relationship between SL and other linear measurements such as BW, AL, SW, SD and LT showed an allometric pattern, where SL gained faster increments than other shell parameters. These relationships can be expressed as: $BW = 6.83\ SL^{0.67}$; $AL = 4.38\ SL^{0.72}$; $SW = 8.50\ SL^{0.53}$; $SD = 5.42\ SL^{0.41}$; and $LT = 1.39\ SL^{0.09}$. These equations can be used to predict the values of BW, AL, SW, SD and LT with a known SL. Moreover, the obtained relationship can be used to distinguish the population of dog conch from Infanta, Pangasinan to other areas where the species are present and exploited.

References

[1] Cob ZC, Arshad A, Bujang JS, Ghaffar MA. On the biology and basic characteristics of the population dynamic of the dog conch, *Strombus canarium* Linnaeus, 1758 (Strombidae). Journal of Biosciences. 2009; 19: 91-97.

[2] Cob ZC, Arshad A, Bujang JS, Bakar Y, Simon KD, Mazlan AG. Habitat preference and usage of *Strombus canarium* Linnaeus, 1758 (Gastropoda: Strombidae) in Malaysian seagrass beds. Italian Journal of Zoology. 2012; 79(3): 459-467.

[3] Husna WNWH, Mazlan AG, Cob ZC. Ontogenetic changes in feeding and food preferences of the dog conch *Laevistrombus canarium* Linnaeus 1758 (Mollusca: Gastropoda) from Merambong shoal, Malaysia. Chinese Journal of Oceanology and Limnolology. 2017; 35: 1230-1238.

[4] Putra RD, Saputra R, Karlina I, Nugraha AH, Idris F, Suhana MP, Febrianto T, Anggraeni, R, Putra IP, Koenawan CJ. Feeding habit of Strombus canarium in Tanjung Sebauk Bintan Island, Indonesia. IOP Conf. Series: Earth and Environmental Science. 2021; 744: 012059.

[5] Husna WNWH, Nurul-Amin SM, Ghaffar MA, Cob CZ. Food consumption and assimilation of the adult dog conch *Laevistrombus canarium* (Linnaeus 1758) at different temperatures. Malaysian Journal of Science. 2019; 38(2): 98-114.

[6] Ramses, Syamsi, F, Notowinarto. Length-weight relationship, growth patterns and sex ratio of dog conch *Strombus canarium* Linnaeus, 1758 in the Waters of Kota Batam. Omni-Akuatika. 2019; 15(1): 19-29.

[7] Manajit N, Theerapoonrat Y, Amornpiyakrit T, Yingyuad W, Soonsan P, Bunlipatanon P, Praipanapong S. Habitat Conservation and Resources Enhancement in Seagrass Beds in Sriboya Island, Krabi Province, Thailand. 2016. Available at: https://repository.seafdec.or.th/bitstream/handle/20.500.12067/704/ManajitN2016.pdf;jsessionid=D83E4259B370CE5F8D7BAA25250EAF19?sequence=1

[8] Chang YC, Ma CH, Lee HT, Hsu TH. Polyculture of juvenile dog conch *Laevistrombus canarium* reveals high potentiality in integrated multitrophic aquaculture Biology. 2021; 10(8): 812.

[9] Brillantes SG, Lagumaby IJ, Balindo DS. Reproductive characteristics of *Strombus canarium* (Gastropoda: Strombidae) in Samar, Philippines. Iranian Journal of Fisheries Science. 2024; 23(6): 911-923.

[10] Umroh U, Bengen DG, Riani E, Prartono T. Environmental factors impact on the length-weight relationships of dog conch (*Laevistrombus canarium*) in the coastal waters of Bangka Island, Indonesia. AACL Bioflux. 2021; 14(6): 3788-3798.

[11] Thongboon L, Niyomdecha S, Suwanjarat J, Muenpo C. Reproductive cycle of *Laevistrombus canarium* (Littorinimorpha: Strombidae) in Krabi Province, Andaman Sea, Thailand. International Journal of Aquatic Biology. 2022; *10*(3): 187-200.

[12] Bhakat S, Sinha AK, De P. Length-weight, length-length relationships and condition factor of *Gagata rhodobarbus* Bhakat & Sinha, 2019 (Siluriformes, Sisoridae). *International Journal of Fisheries and Aquatic Studies*. 2019; *7*(5): 365-369.

[13] Biole FG, Volpedo AV, Thompson GA. Length-weight and length-length relationship for three marine fish species of commercial importance from southwestern Atlantic Ocean coast. Latin American Journal of Aquatic Resources. 2020; *48*(3).

[14] Shejwal P, Wagh D, Patil M. Shell length study for a prediction of morphometric traits in freshwater snail Lymnaea acuminata. Journal of Entomology and Zoological Studies. 2016; 4(6): 252-255.

[15] Eschweiler N, Molis M, Buschbaum C. Habitat-specific size structure variations in periwinkle populations (*Littorina littorea*) caused by biotic factors. Helgoland Marine Research. 2009; *63*: 119-127.

[16] Saura M, Rivas MJ, Diz AP, Caballero A, Rolan-Alvarez E. Dietary effects on shell growth and shape in an intertidal marine snail, *Littorina saxatilis*. *Journal of Molluscan Studies*. 2012; *78*(2): 213-216.

[17] Colvin CN, Hollyman PR, Richardson CA, Chenery SRN, Waggitt JJ, McCarthy ID. The effect of environmental factors on shell growth and repair in *Buccinum undatum*. Journal of Experimental Marine Biology and Ecology. 2022; *551*: 151720.

[18] Munandar A, Supriyono E, Nirmala K, Hastuti YP, Dwiono SAP. The effect of different salinity levels on the production performance and physiological response of juvenile gold-mouth snail *Turbo chrysostomus* Linnaeus, 1758. AACL Bioflux. 2022; *15*(5): 2299-2309.

[19] Reyes AT, Agbisit KMB, Darca LG, Marquez RC, Quilinguin JB. (2020). Morphometry and length-length relationship of *Jagora* spp. collected from the river and stream of Aurora Province, Philippines. *International Journal of Biology Sciences*. 2020; *2*(1): 18-21.

[20] Irniger A, Morari MJ, Burkli A, Detert M. Automatic high-throughput measurement of live aquatic snails from images. *Journal of Molluscan Studies*. 2017; *83*(2): 235-239.

[21] Man in't Veld LA, De Turck K. Contributions to the knowledge of Strombacea 6: A revision of the subgenus Laevistrombus Kira, 1955 including the description of a new species from the New Hebrides. *Gloria Maris*. 1998; *36*: 73-107.

[22] Foley JR, Takahashi M. Shell lip thickness is the most reliable proxy to sexual maturity in Queen Conch (*Lobatus gigas*) of Port Honduras Marine Reserve, Belize; Informing management to reduce the risk of growth overfishing. Frontiers of Marine Science. 2017; *4*.

[23] Ruaza Jr FC, Dy DT. Morphological Variation in the Shell of *Strombus* (Mollusca: Gastropoda) Across Several Local Habitats in Surigao del Sur, Southern Philippines. SDSSU Multidisciplinary Research Journal. 2016; *4*: 11-16.

[24] Ismail NS, Elkarmi AZ. Age, Growth and Shell Morphometrics of the Gastropod *Monodonta dama* (Neritidae:Prosobranchia) from the Gulf of Aqaba, Red Sea. Pakistan Journal of Biological Sciences. 2006; *9*(5): 843-847.

[25] Allsay KAC, Dwi EDS. Shell morphology and size distribution of Turbo spp in Sepanjang Beach by shell collecting: An Initial Survey. Bio Web of Conferences. 2023; 70: 03003.

[26] Doyle D, Gammell MP, Nash R. Morphometric methods for the analysis and classification of gastropods: a comparison using *Littorina littorea*. Journal of Molluscan Studies. 2018; *84*(2): 190-197.

[27] Mojekwu TO, Anumudu CI. Advanced techniques for morphometric analysis in fish. Journal of Aquaculture Research and Development. 2015; *6*: 354.

[28] Matos AS, Matthews-Cascon H, Chaparro OR. Morphometric analysis of the shell of the intertidal gastropod *Echinolittorina lineolata* (d'Orbigny, 1840) at different latitudes along the Brazilian coast. Journal of the Marine Biological Association of the United Kingdom. 2020; *100*(5): 725-731.

[29] Tripathy SK. Significance of traditional and advanced morphometry to fishery science. Journal of Human, Earth and Future. 2020; *1*(3), 153-166.