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Length-Weight Relationships of the Asian Green Mussel, Perna viridis (Linnaeus 1758) (Bivalvia: Mytilidae) Population in Bolinao Bay, Pangasinan, Northern Philippines

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Abstract — **A morphometric study was conducted on the population of *Perna viridis* in Bolinao Bay to assess the ideal weight growth estimator. A total of 243 individual mussels were used to determine the relationships of shell length (SL), shell width (SW) and shell thickness (ST) with the total weight (TW) and soft tissue weight (STW) of the bivalve. All length-weight relationships established showed negative allometric growth with b-values ranging from 2.30-2.71. Highest correlation values were observed in the SL-TW (r^2 = 0.82) and SL-STW (r^2 = 0.85) relationships. This indicates that shell length is the ideal weight growth estimator for the green mussel population in Bolinao Bay.**

Key Words — Length-Weight Relationship, Green Mussel, Bivalve, Bolinao Bay

I. INTRODUCTION

Green mussel (*Perna viridis*) or locally known as "tahong" is one of the most popular mollusc species not only here in the Philippines but also in the whole world because of its relationship with the red tide-causing organisms.

More than ten years ago, the coastal waters of Pangasinan were free from the occurrence of red tide, but now it has become a problem in the aquaculture industry. With the emergence of green mussel *Perna viridis* as a new mollusc species, red tide has also emerged as a new problem in the coastal waters of Bolinao in Western Pangasinan.

At present, data on the morphometric relationships of the mussel species growing in Bolinao Bay are limited. This species is now gaining high demand not only in the municipality of Bolinao, but also in the whole province of Pangasinan. The use of Length-Weight Relationship (LWR) is very important for the assessment of the growth and production of this species. According to Froese (2006), weight–length relationships (WLR) are used for estimating the weight corresponding to a given length, and condition factors are used for comparing the condition, fatness, or well-being of species, based on the assumption that heavier organism of a given length are in better condition. Both concepts have been used in fisheries research since the beginning of the 20th century.

There have been several morphometric studies done for bivalves. Specifically, these works were conducted to differentiate species, determine shell dimension-volume relationships, and describe the population dynamics. Morton (1984) reviewed the *Polymesoda* species from the Indo-Pacific mangroves. He tried to discriminate *P. erosa* and *P. expansa* by analyzing shell dimensions of specimens from Singapore. He offered the shell height-shell length and ligament length-shell length relationships as possible features that would allow future separation of the species. Gimin *et al.* (2004) reported that the northern Australian *P. erosa* shell dimensions (length, height, width) were good estimators of growth when applied to live weight (r^2 = 0.759-0.956). However, relationships between shell dimensions and soft tissue weights appeared to have low correlations (r^2 = 0.132-0.318), hence, were not good growth estimators. Allometric relationships were significantly different between clams during wet and dry seasons.

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Campos *et al.* (1998) and Aristizabal (2010) studied the populations of *P. radiata* and *P. solida*, respectively, in Central America to determine length-weight relationships and other growth parameters. The Costa Rican *P. radiata* population was observed to have an isometric length-weight relationship ($W = 0.0207L^{3.01}$). Its individual growth rate was estimated at 0.66 mm month^{-1} for the first year of existence. The Colombian *P. solida* populations from three interconnected lagoons showed isometric growth in Poza Verde ($W = 0.000L^{2.993}$) and negative allometric growth in El Torno ($W = 0.0006L^{2.8255}$) and Atascosa ($W = 0.0021L^{2.4392}$). Measurements of individual shell lengths of Hong Kong clam *P. erosa* (Morton, 1988) and Colombian clam *P. solida* (Rueda and Urban, 1998) were done to come up with length-frequency data which described the population dynamics of the two species.

This study focused on the morphometric relationships of *Perna viridis* in Bolinao Bay to gather useful data in management and conservation of mollusc resources of the Bay. Specifically, the study aimed to determine the morphometric relationships of *Perna viridis* collected in Bolinao Bay in terms of: (1) shell-length and total weight; (2) shell-width and total weight; (3) shell- thickness and total weight; (4) shell-length and soft-tissue weight; (5) shell-width and soft-tissue weight; and (6) shell-thickness and soft-tissue weight.

II. Materials and Methods

Live *Perna viridis* samples were obtained from the mussel farmers and gatherers in Bolinao Bay. The samples were cleaned by removing all algae and dirt attached to their shells before taking the needed morphometric measurements. Measurements of shell dimensions (length, width and thickness) were made using Vernier caliper. Total weight of the individual sample was determined using a digital weighing balance with a sensitivity of 0.01 gram. The meat (soft tissue) of the individual sample was separated from the shell by shucking and was then weighed to determine soft-tissue weight (STW). . All data gathered were recorded and analyzed with the aid of Microsoft Excel 2007 version. The estimation of morphometric relationships of important variables were made using the formula $W = aL^b$.

III. Results and Discussion

A total of 243 *Perna viridis* were collected in Bolinao Bay during the study period. The relationships between shell dimensions (length, width and thickness) to total weight and soft-tissue weight in grams of the mollusc were independently evaluated using simple regression analysis. Morphometric relationships established for *Perna viridis* can be seen from Figures 1 to 6.

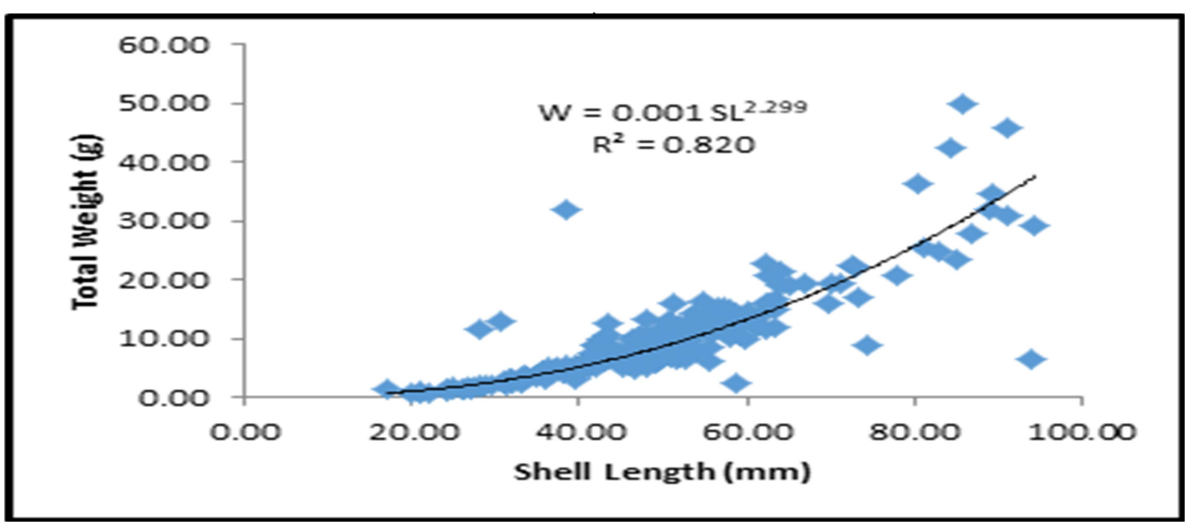

Figure 1. *Relationship between total weight and shell length of green mussel, Perna viridis.*

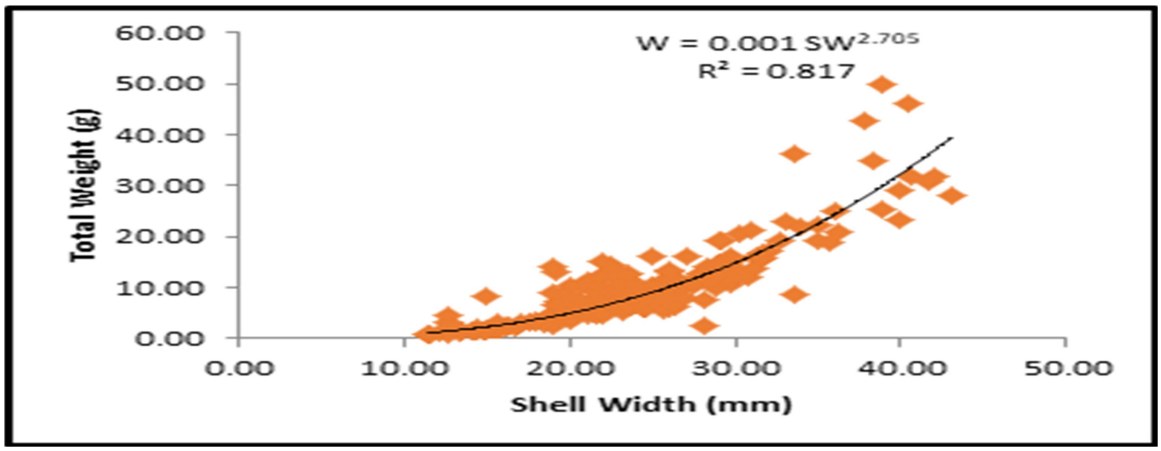

Figure 2. *Relationship between total weight and shell width of green mussel, Perna viridis*

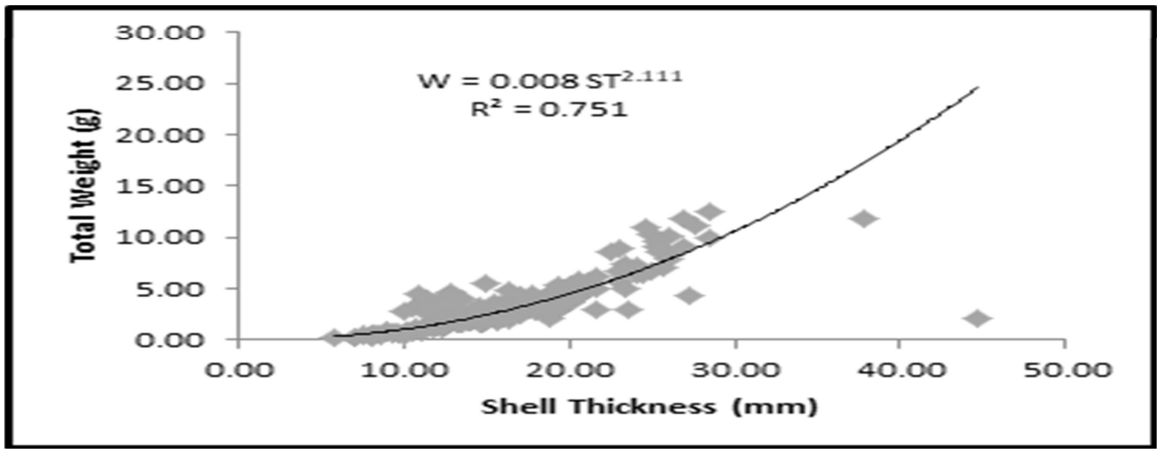

Figure 3. *Relationship between total weight and shell thickness of green mussel, Perna viridis.*

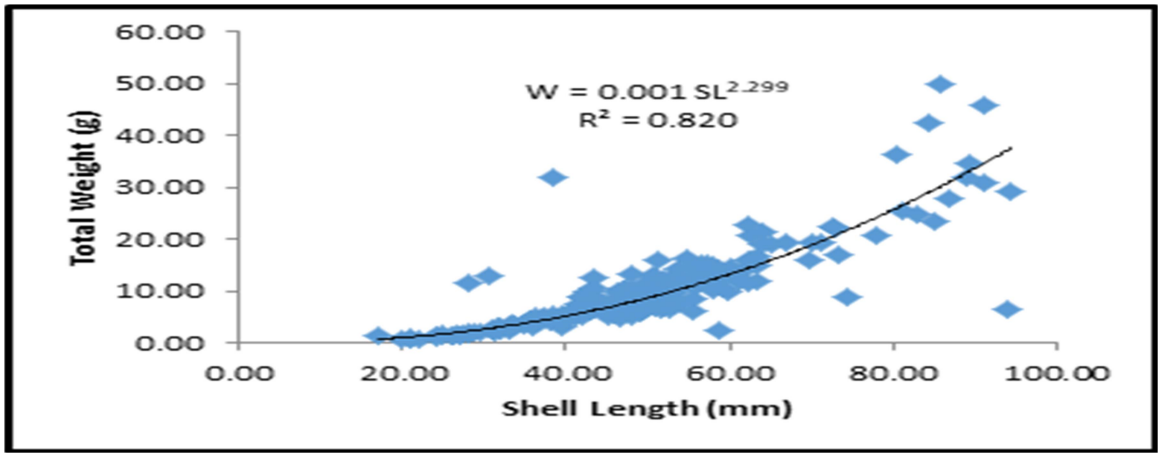

Figure 4. *Relationship between soft tissue weight and shell Length of green mussel, Perna viridis*

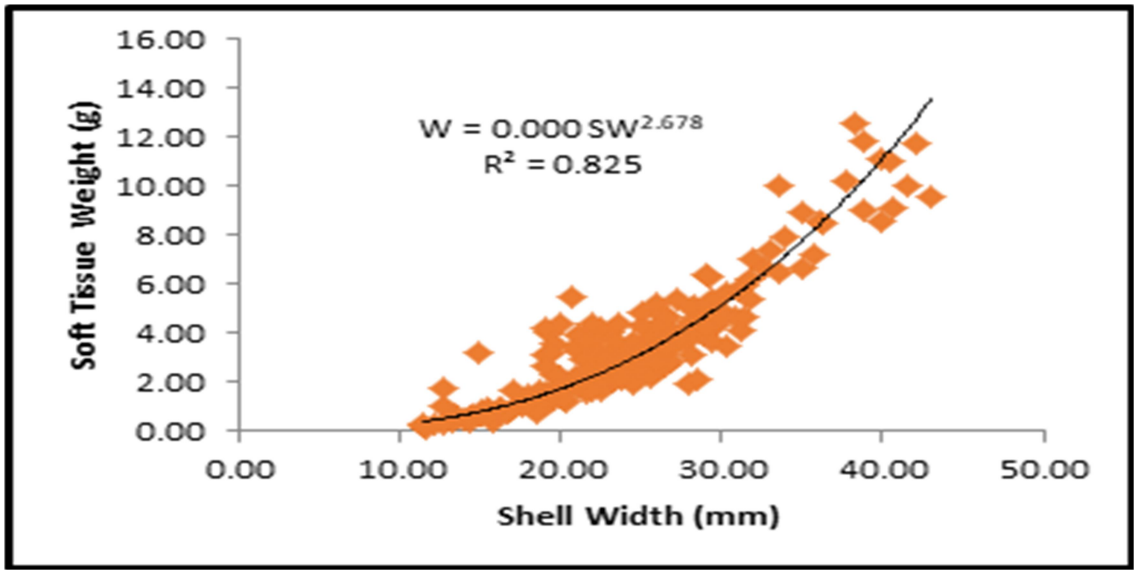

Figure 5. *Relationship between soft tissue weight and shell width of green mussel, Perna viridis*

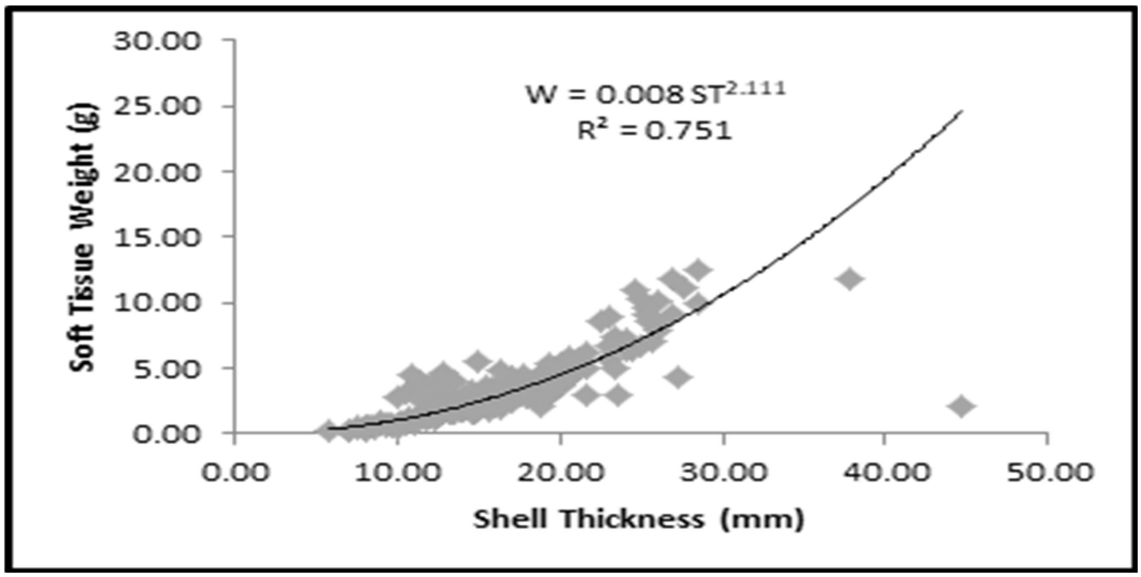

Figure 6. *Relationship between soft tissue weight and shell thickness of green mussel, Perna viridis.*

Results of the morphometric analysis (Table 1) revealed that shell dimensions such as length, width and thickness bared a strong positive correlation with total weight and soft tissue weight. The values obtained infer that there was a proportionate increase in the total weight and soft tissue weight of green muscle samples with increases in shell length, width and thickness of the species. In all cases, the values of correlation coefficients were close to one, but SW (shell width) - STW (soft-tissue weight) was greater than all paired morphometric parameters.

TABLE 1. SUMMARY OF THE RELATIONSHIPS BETWEEN SHELL DIMENSIONS AND TOTAL/SOFT TISSUE WEIGHT, AND GROWTH PATTERNS OF *PERNA VIRIDIS* IN BOLINAO BAY

Variables	r	r^2	Intercept (a)	Regression Coefficient (b)	Growth (t-test)	Growth Pattern
Total weight vs. shell length	.906	.820	0.001	2.299	b<3	Allometric
Total weight vs. shell width	.904	.817	0.001	2.705	b<3	Allometric
Total weight vs. shell thickness	.866	.751	0.008	2.111	b<3	Allometric
Soft tissue weight vs. shell length	.923	.851	0.000	2.308	b<3	Allometric
Soft tissue weight vs. shell width	.908	.825	o.ooo	2.678	b<3	Allometric
Soft tissue weight vs. shell thickness	.866	.751	0.008	2.111	b<3	Allometric

Coefficient of determination on the other hand was higher also in the case of SW-STW relationships. The corresponding value implies that almost 83% of the total variation in the soft-tissue weight was accounted for by the relationship with the values of shell width. Overall, results of the statistical analysis showed a significant relationships (P <0.01) between paired variables. This suggests that there was an increase in the both total weight (TW) and soft tissue weight (STW) of the species as its shell length (SL), shell width (SW) and shell thickness (ST) increases over time.

Relationships of the morphometric parameters of shellfish is a measure of weight-growth and when the parameter "b" is equal to 3.0, the organisms are tend to show an isometric growth pattern and when the values are greater or lesser than the isometry situation, it is said to be that the sampled species is growing in a positive (b>3.0) or negative (b<3.0) way.

In this study, "b" values for SL-TW, SW-TW, ST-TW, SL-STW, SW-STW, and ST-STW relationships were 2.299, 2.705, 2.111, 2.308, 2.678, and 2.111, respectively. Confirmation of the "b" values obtained whether it is significantly different to 3.0 was made using the t-test modified by Pauly (1980) and results showed values of the parameter "b" in all cases were significantly different to the isometric value. This result conferred with the statement of Gayanilo and Pauly (1997) that the growth of the organism proceeds in a "different" dimension differing from the cube of the length. It was also noted that the slopes of the paired morphometric characteristics were lesser than 3.0. This means that green mussels collected from Bolinao Bay are growing in a negative allometric way and suggested that the rate of increase in shell length, shell width, and shell thickness is not proportional to the rate of increase in total weight and soft-tissue weight. Based from the result of the morphometric analysis, "b" value of the shell-length against total weight did not conformed to the observation of Wilbur and Owen (1964) that most mollusks have a slope between 2.5 and 4.5. Compared to the studies conducted by Rao et al. (1975) and Qasim et al. (1977), Sundaram et al. (2011) and Narasimham (1980) on the length-total weight relationships of *Perna viridis* in Goa, Versova creek and Kakinada Bay, respectively, value of "b" in this present study is lower. The "b" values obtained by these authors varied from 2.4175 to 2.8616.

According to Babaei et al. (2010), bivalve shell growth and shape are influenced by biotic (endogenous/ physiological) and abiotic (exogenous/environmental) factors. Among these factors that affect the growth of mussels are the quality and quantity of food source, water quality, water depth, currents, water turbulence, type of sediments, type of bottom and wave exposure. Negative allometric growth pattern showed by the green mussels in Bolinao Bay indicates that the species favored the factors affecting its biological condition.

In accordance to the study conducted by various authors, morphometric characteristics of green mussels can be an essential reference for monitoring and evaluation of the growth and condition of the species especially in the natural or wild population.

The present study attempted to provide essential information on the morphometric relationships of Green mussel (*Perna viridis*) cultured and gathered in Bolinao Bay and can be a useful reference for fisheries biologists and conservation agencies for the successful development and production of the said species. In conclusion, all length-weight relationships established showed negative allometric growth with b-values ranging from 2.30-2.71. Highest correlation values were observed in the SL-TW (r^2 = 0.82) and SL-STW (r^2 = 0.85) relationships. This indicates that shell length is the ideal weight growth estimator for the green mussel population in Bolinao Bay. Further study should be conducted along this line using green mussel samples collected from other coastal waters of the province of Pangasinan.

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