Biometric relationships of the black-lip pearl oyster, Pinctada margaritifera from North Sulawesi waters, Indonesia

by Ockstan Jurike Kalesaran

Biometric relationships of the black-lip pearl oyster, *Pinctada margaritifera* from North Sulawesi waters, Indonesia

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Abstract. North Sulawesi province has marine waters with an area of 314,983 km^2 and coastline of 1,837 km, with high marine biodiversity. One of the aquatic biota on that seascape is the black-lip pearl oyster, *Pinctada margaritifera* with local name "*bia kapi-kapi*" is found abundantly, but information on this population is still very limited. This study aims to analyze the biometric relationships of *P. margaritifera* from North Sulawesi waters. The biometric parameters observed were shell length (SL), shell width (SW), and shell thickness (ST) measured using Digital Vernier Calipers; and total weight (TW), wet meat weight (WMW), and shell weight (Sw) were obtained using Ohaus digital scales. The size of *P. margaritifera* was dominated by medium size ranging from 8 to 11 cm shell length (43.52%) with an average of 8.72 cm long. This record indicates that the oysters are still in growing process. Biometric relationship of *P. margaritifera* from North Sulawesi waters by considering all shell dimensions showed very high correlation. This result shows a negative allometric growth.

Key Words: shell dimension, allometric growth, bia kapi-kapi, biometric parameters, North Sulawesi.

Introduction. Indonesia is an archipelagic country whose entire area is surrounded by sea with abundant marine biological resources. Recently, Indonesia's future economic development program puts the sea as a strategic sector of national foreign exchange objectives (Noegroho 2013). Marine-based development and maritime resources exploitation continue to be optimized and become a mainstay of national economic development and competitiveness (Jusuf 2016).

North Sulawesi province has marine waters with an area of 314,983 km^2 and length of coastline 1,837 km with high marine biodiversity (Noegroho 2013). It is estimated that 60 percent of marine biota species in the world can be found in North Sulawesi waters. One of the potential marine biota known is *Pinctada margaritifera* or black-lip pearl oyster. This type of oyster has an important economic value and can be used to produce jewelry, buttons, and decorations/home decoration (Ellis & Hows 1999).

Many studies that have been done up to now focused mainly on bivalve (Southgate & Lucas 2008; Bayne 2017; Lumenta et al 2017; Asadi et al 2018) and biometric relationships (Jha & Mohan 2014; Octavina et al 2015; Liang et al 2016; Lore et al 2016; Vasconcelos et al 2018). Elamin & Elamin (2014) examined the biometric parameters to evaluate growth model focusing on the length-weight relationship of *P. margaritifera*. Meanwhile, El-Sayed et al (2011) stated that the proper assessment of oyster management depends on length-weight relationship information. Furthermore, Sisilia (2000) claims that oyster growth can be indicated through shell growth. For these reasons, Aideed et al (2014) studied growth in relation with allometric growth pattern. Such a research is necessary to obtain valuable information that can be used for resource management to address changes in environmental conditions and pollution. The same study has also been conducted by Abraham et al (2007) which stated that in all size groups of *P. margaritifera*, weight gain is associated with length increases.

P. margaritifera, also locally known as *"bia kapi-kapi"* is found to be abundant in North Sulawesi waters. Unfortunately, information on their population is still very limited. This study aims to analyze the biometric relationships of *P. margaritifera,* from North Sulawesi waters using one of the most commonly used methods in the study of oyster populations, i.e. the biometric parameter analysis approach.

Material and Method. The research was conducted in November 2017 to January 2018. Sampling was carried out in two locations, Bahoi (coastal area of North Minahasa District) and Arakan (coastal area South Minahasa District), North Sulawesi Province (Figure 1). One-hundred and eight individuals were collected manually by diving, then the dirt inherent were scraped and cleaned.

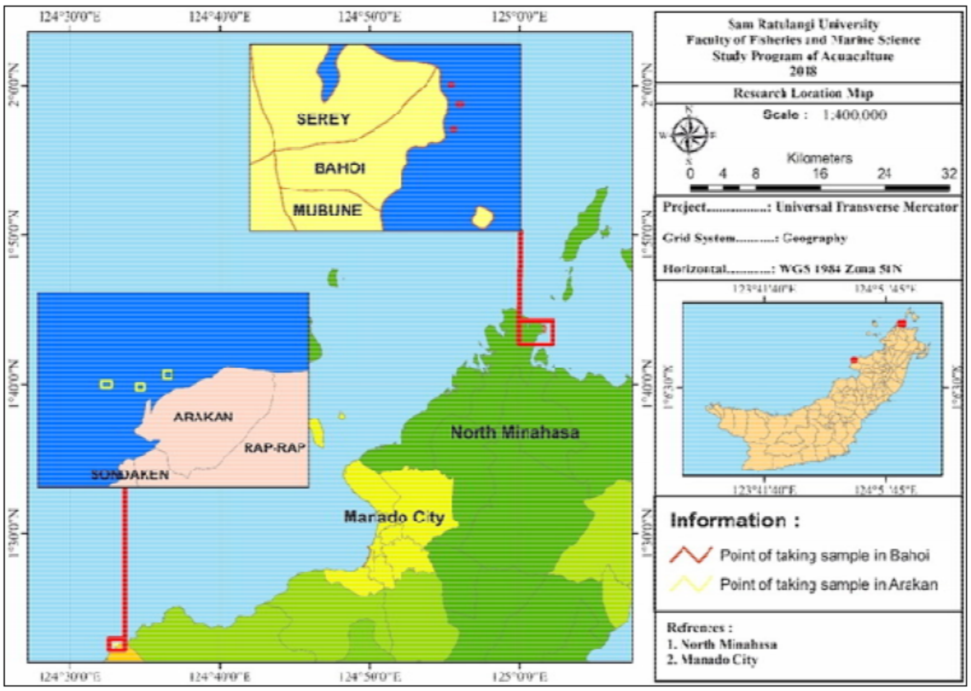

Figure 1. Sampling locations.

Morphometric measurements observed in this study included shell length (SL), shell width (SW), and shell thickness (ST). All parameters were measured using 0.01 mm Digital Vernier Calipers. The shell length was measured from the dorsal end to the ventral tip, the width of the oyster measured from the anterior edge to the posterior end, and the oyster thickness measured from the distance between the right shell and the left shell (Figure 2). The total weight (TW) of the oyster, wet meat weight (WMW), and shell weight (Sw) of the oyster were obtained using an Ohaus digital scale of 0.01 g. These measurements were done in the Laboratory of Faculty of Fisheries and Marine Sciences, Sam Ratulangi University, Manado.

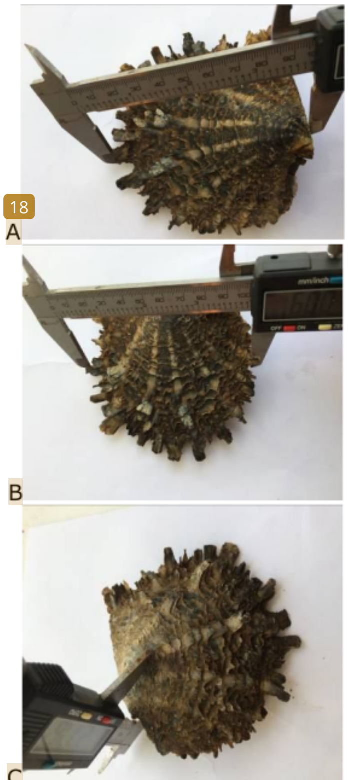

Figure 2. Morphometric measurements of *P. margaritifera* (A = shell length (SL), B = shell width (SW), C = shell thickness (ST).

Data analysis. *P. margaritifera* samples were grouped into 3 size classes, small class (SL < 8 cm), medium class (SL = 8-11 cm), and large class (SL > 11 cm). Biometric relationship analyses were accomplished on SL, SW, and ST against TW of shell, WMW, and Sw of oyster. Length-weight relationships were analyzed through quadratic equations (Sisilia 2000; Elamin & Elamin 2014; Aideed et al 2014; Mondol et al 2016), with the formula:

$$Y = a X^{b}$$

where: Y = weight (total weight, wet meat weight, or shell weight (g));
X = the length of the shell or the width of the shell or the thickness of the shell (cm);
a (intercept) and b (slope) parameters.

Data analysis for biometric parameter relationships was performed using Microsoft Excel 2010. The growth model (isometric or allometric) was determined by looking at the value of b obtained from biometric data analysis. Oyster growth is considered as isometric if b equals to 3 and allometric if b does not equal to 3. The value of $b < 3$ is negative allometric and $b > 3$ is positive allometric (Sangun et al 2007; Elamin & Elamin 2014).

Results and Discussion. SL of *P. margaritifera* collected in two locations of North Sulawesi waters varied from 4.39 to 13.95 cm long with mean shell length of 8.72 cm. Three length classes separated are given in Table 1.

P. margaritifera from North Sulawesi waters was dominated by medium class (SL = 8-11 cm) accounting for 43.52% of the total samples measured, followed by small class (SL < 8 cm), 39.81%, and large size class (SL > 11 cm), 16.67%. The dominance of medium class shows that the oyster is in growing process. According to Pouvreau & Prasil (2001), the general growth rate is directly related to the age of bivalves. The growth of *P. margaritifera* progresses rapidly until the third year and gets slower thereafter. Mean size of 119-135 mm of this species belongs to 3 years old group (Pouvreau & Prasil 2001). In this study, the dominance of medium class belonged to 2-year class and they had rapid growth rate. Size variations were found in fishing activities, in which large sizes were likely to be more accessible to be collected. This oyster collection activity leads to a decline in biomass and number of large size oyster in nature and a growing opportunity for small and medium-sized individuals (Table 2).

Table 1

Sample size classes recorded

Class of shell length interval	*Bahoi*	*Arakan*	*Total*	*Percentage (%)*
< 8 cm (small)	23	20	43	39.81
8-11 cm (medium)	17	30	47	43.52
> 11 cm (large)	4	14	18	16.67
Total			108	100

Table 2

Biometric measurement of shell length (SL), shell width (SW), shell thickness (ST), total weight (TW), wet meat weight (WMW), and shell weight (Sw) of *P. margaritifera* from North Sulawesi waters

Parameters	*Measurement results*		
	Min - Max	*Mean*	*SD*
Shell length - SL (cm)	4.39-13.96	8.72	2.12
Shell width - SW (cm)	4.17-13.33	8.29	2.02
Shell thickness - ST (cm)	1.28-5.19	2.69	0.71
Total weight - TW (g)	11.53-250.64	85.53	54.23
Wet meat weight - WMW (g)	2.2-35.81	14.45	8.59
Shell weight - Sw (g)	8.29-222.55	69.16	43.76

The calculation of length and weight relationships was conducted to predict the growth patterns of aquatic organisms. The results showed that SL and TW of oyster had very strong correlation described by the equation $Y = 0.2406 X^{2.6478}$ and $R^2 = 0.8968$ (Figure 3).

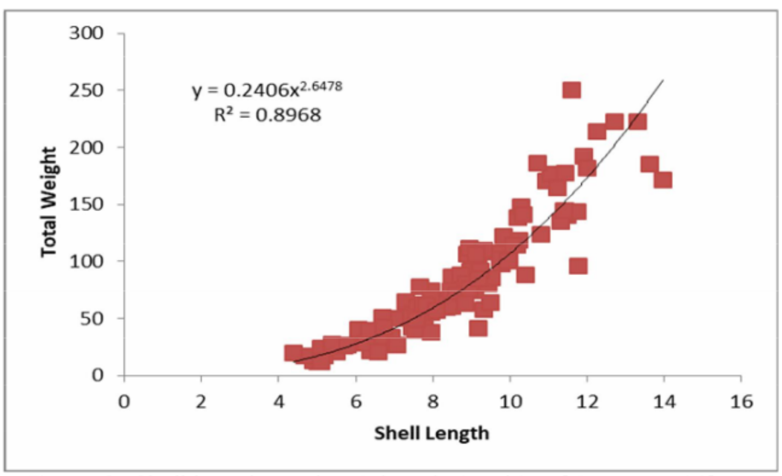

Figure 3. Shell length-total weight relationship of *P. margaritifera*.

The SW and the TW relationship of the oyster have a very strong correlation as described by the equation $Y = 0.29X^{2.6212}$ and $R^2 = 0.8628$ (Figure 4).

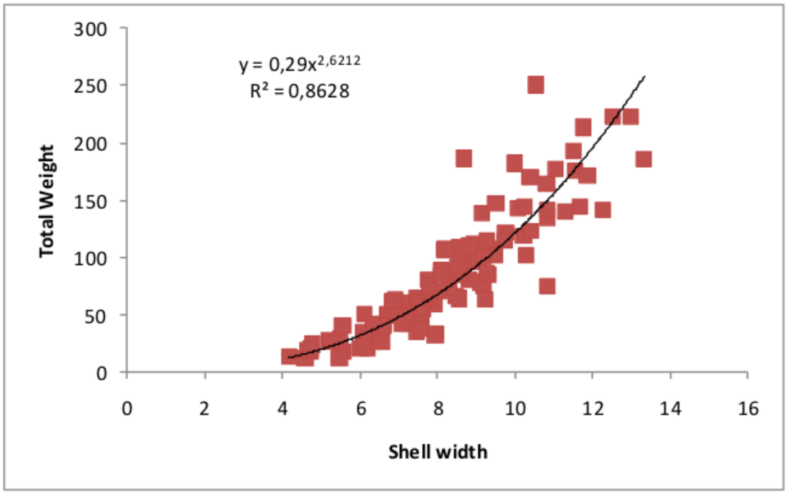

Figure 4. Shell width-total weight relationship of *P. margaritifera*.

The ST and the TW of the oyster have also very strong correlation, as described by the equation $Y = 6.7927X^{2.4104}$ and $R^2 = 0.807$ (Figure 5).

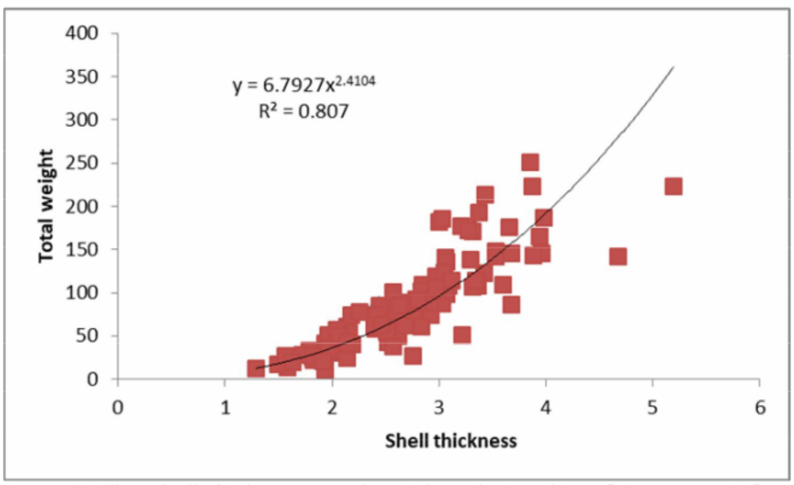

Figure 5. The shell thickness-total weight relationship of *P. margaritifera*.

The relationship of SL and WMW of oyster is a very strong as well, and can be described through the equation Y = $0.0547X^{2.5125}$ and R^2= 0.8775 (Figure 6).

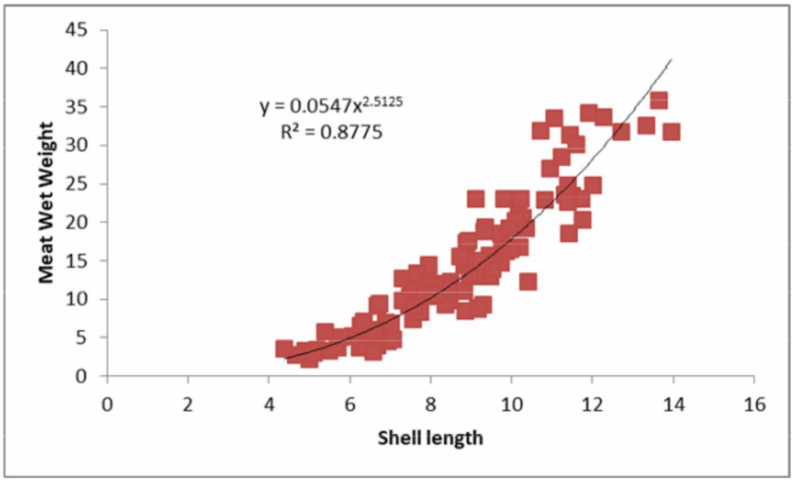

Figure 6. Shell length-wet meat weight relationship of *P. margaritifera*.

The SW and the WMW of oyster have a very strong correlation as described by the equation Y = $0.0636X^{2.5004}$ and R^2 = 0.8532 (Figure 7).

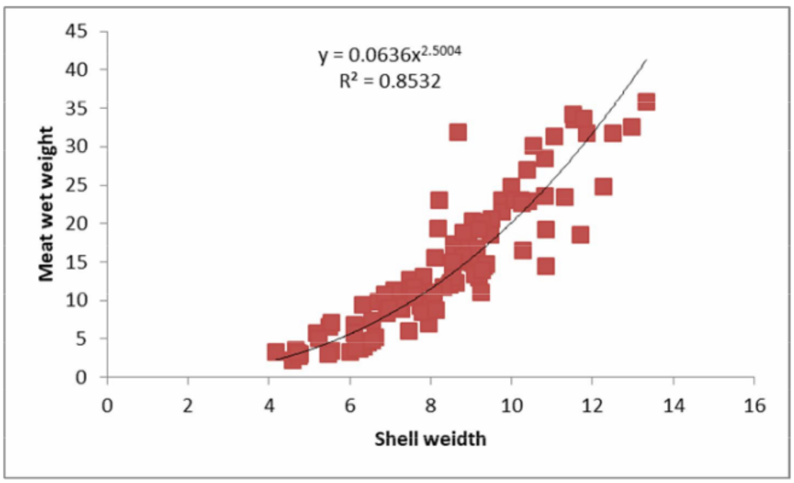

Figure 7. Shell width-wet meat weight relationship of *P. margaritifera*.

The ST and the WMW of the oyster have a strong correlation, described by the equation $Y = 1.3951X^{2.2154}$ and $R^2 = 0.7408$ (Figure 8).

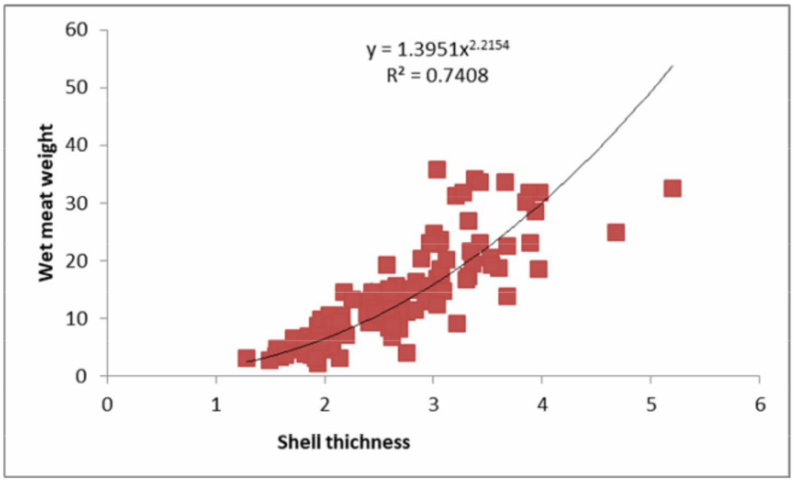

Figure 8. The thickness of shell-wet meat weight relationship of *P. margaritifera*.

The relationship of SL and Sw of oyster is also very strong as described by the equation $Y = 0.2142X^{2.6024}$ and $R^2 = 0.8488$ (Figure 9).

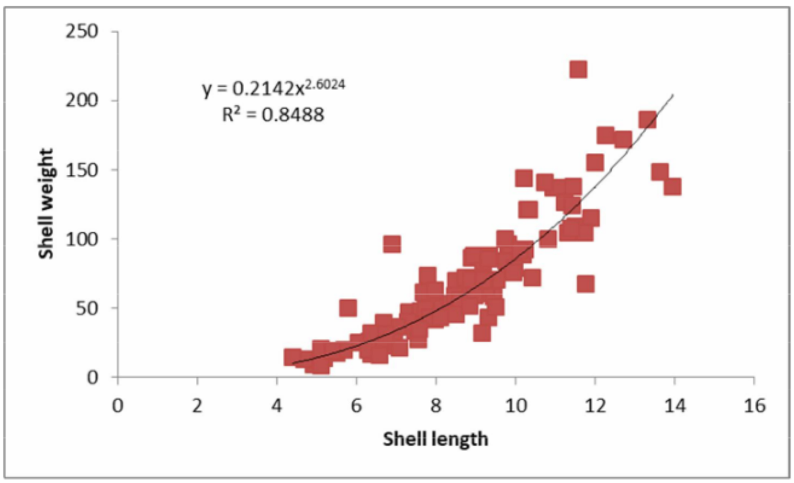

Figure 9. Shell length-shell weight relationship of *P. margaritifera*.

The SW and the Sw have very strong correlation as described by the equation Y = $0.2411X^{2.6075}$ and R^2 = 0.8366 (Figure 10).

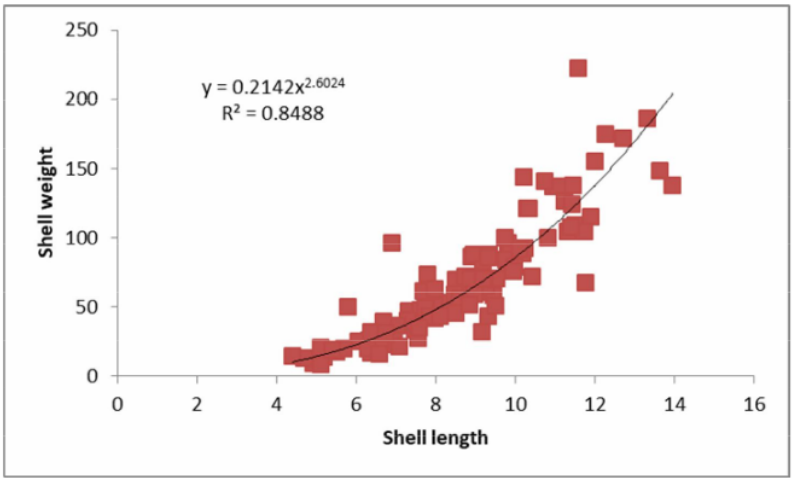

Figure 10. Shell width-shell weight relationship of *P. margaritifera*.

The relationship of ST and Sw of oyster is strong as well as described by the equation Y = $5.5072X^{2.3979}$ and R^2 = 0.7683 (Figure 11).

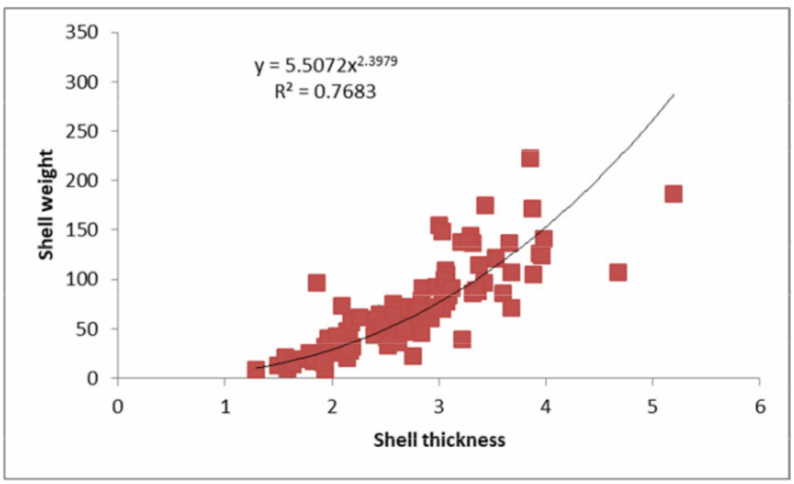

Figure 11. The thickness of the shell-shell weight relationship of *P. margaritifera*.

In the present study, R^2 value (coefficient determinations) ranged between 0.7408 and 0.8969 (Figures 3 to 11). This means that the effect of variable x (SL, SW, ST) on variation of variable y (TW, WMW, Sw) ranges from 74 to 89%. Values of b were found less than 3 for all relationships between length, width, and thickness versus total weight, wet meat weight, and shell weight, indicating that the oyster has negative allometric growth.

The growth of *P. margaritifera* is usually described in terms of the increase in shell size or measured by weight, width, thickness and length (Sisilia 2000; Mondol et al 2016). According to Elamin & Elamin (2014), length-weight relationship is an important biological parameter needed to evaluate the growth mode of a species. The biometric relationship of *P. margaritifera* from North Sulawesi waters by considering all shell dimensions showed very high correlation.

The relationship between SL and other dimensions in bivalves could give an idea about the pattern of shell growth or it is dimensional changes (de Paula & Silveira 2009). The results of this study indicate that the value of b < 3 for all relationships between shell length (SL), shell width (SW) and shell thickness (ST) to total weight (TW), wet meat weight (WMW), and shell weight (Sw). This shows that the growth pattern of *P. margaritifera* from North Sulawesi waters on all dimensions of measurements is considered negative allometric (Table 3), meaning that the length increment is faster than the weight gains.

The same result was reported by Elamin and Elamin (2014) on *P. margaritifera* var *erytharaenensis* with negative allometric pattern. On the contrary, the study result of El-Sayed et al (2011) indicates isometric growth pattern instead. This is probably due to different water conditions that affect the growth pattern of an organism. According to Mohamed et al (2006), Chin-Long & Le Moullac (2017), and Octavina et al (2017), growth pattern and the biometric relationships in *Pinctada fucata* are strongly influenced by environmental conditions. Moreover, Shirai (1994), Wada et al (1995), O'Connor (2002), and El-Sayed et al (2011) explain that this difference is mostly probably related to differences in water quality, food availability and habitat type of the surrounding environment causing certain population grow faster with much thinner shells.

Table 3

Growth pattern of black-lip pearl oyster, *P. margaritifera*

No.	*Variable*		*a value*	*b value*	*R^2 value*	*Growth pattern*
	Response variable	*Independent variable*				
1	SL	TW	0.2406	2.6478	0.8968	Negative allometric
2	SW	TW	0.29	2.6212	0.8628	Negative allometric
3	ST	TW	6.7927	2.4104	0.807	Negative allometric
4	SL	WMW	0.0547	2.5125	0.8775	Negative allometric
5	SW	WMW	0.0636	2.5004	0.8532	Negative allometric
6	ST	WMW	1.3951	2.2154	0.7408	Negative allometric
7	SL	Sw	0.2142	2.6024	0.8488	Negative allometric
8	SW	Sw	0.2411	2.6075	0.8366	Negative allometric
9	ST	Sw	5.5072	2.3979	0.7683	Negative allometric

Conclusions. The shell size varied from 4.39 to 13.95 cm long with mean size of 8.72 cm. Medium size class (SL 8 to 11 cm) covered 43.52%, followed by small class (SL < 8 cm), 39.81%, and then large size class (SL > 11 cm), 16.67%. Biometric relationship of the black lip pearl oyster *P. margaritifera* from North Sulawesi waters by considering all shell dimensions showed very high correlation. This result also shows a negative allometric growth pattern. This information is very useful for ecology, fisheries assessment and management of *P. margaritifera*.

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