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Length-weight relationships and condition index of Pokea clams (*Batissa violacea* var. celebensis, von Martens 1897) in the Laeya River, Southeast Sulawesi, Indonesia

Bahtiar Bahtiar[1*], Muhammad Nur Findra[2], Ermayanti Ishak[1]

[1]*Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, Halu Oleo University, Kendari 93232, Indonesia.*
[2]*Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, Khairun University, Ternate 97719, Indonesia.*

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ABSTRACT

The length-weight relationship and condition index of pokea clams in the Laeya River are not fully known. This study was aimed to determine the length-weight relationship and condition index of pokea clams in the Laeya River, Southeast Sulawesi. This research was conducted 10 months from May 2016 to February 2017 in the Laeya River, Southeast Sulawesi. Pokea clams are collected using a shovel. The length and weight of each clam was using calipers and analytical scales with accuracy of 0.05 mm and 0.01 g, respectively. The weight of the shell and dried meat was obtained by drying the shells first using an oven and weighing using an analytical balance with an accuracy of 0.01 g and 0.0001 g, respectively. The results showed that the relationship between length and weight of pokea clams in males and females were 2.61 and 2.78, respectively; with R^2 values of 0.89 and 0.93, respectively. The highest b values for males and females were found in July with values of 3.03 and 2.94, respectively. The lowest b value was found in November with values of 2.45 and 2.46, respectively. The condition index values for males and females were 4.7 ± 2.2 and 5.17 ± 2.32, respectively. The highest condition index was found in May with values of 6.00 ± 3.07 and 7.83 ± 2.55, respectively. The condition index values for males and females increased with increasing shell size. Male and female at the largest size (6.01-6.05 cm) had the highest index with values of 8.05 ± 6.41 and 9.12 ± 3.38, respectively. In conclusions, the growth was negative allometric pattern, condition index was in fat category, and had peak spawning in July and experienced partial spawning in September-February.

Introduction

Pokea clams are pure freshwater organism from the Corbicullidae family (Muzuni *et al.*, 2014). This clam is a species of *Batissa violacea*, Lamarck 1818 (Mayor *et al.*, 2016; Puteri, 2005) which has different variances in each region followed by local names including: Sulawesi (*Batissa violacea* var. celebensis von Martens, 1897), Papua (*Batissa violacea* var jayensis, Kusnoto, 1953) and Fiji Islands (*Batissa violacea* var. kai Ledua, 1996). These clams in Southeast Sulawesi are known as "pokea" or "kerang keha" (Bahtiar *et al.*, 2016). Pokea clams occupy narrow niches of river waters, which are present in all estuarine segments or as far as tidal runoff upstream (Bahtiar *et al.*, 2022a). Like other shellfish, these clams are found in all the textures of aquatic substrates from clay, silt, fine sand, coarse sand and gravel, and are even found between dead tree trunks at the bottom of the waters (Bahtiar and Purnama, 2020). These clams are found in abundance in areas with a texture dominated by clay and sandy loam which utilize deposited detritus as the dominant food on the bottom floor of the waters (Bahtiar *et al.*, 2014). The high ability to utilize food sources on the water floor (detritus) and water column (phytoplankton) through filter feeder and pedal feeder mechanisms has implications for its population growth and high regeneration ability (Bahtiar, 2015; Bahtiar, 2017; Bahtiar *et al.*, 2018), so that pokea play an important role in maintaining and improving water quality (Vaughn *et al.*, 2008).

* Corresponding author.
Email address: bahtiar@uho.ac.id

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On the other hand, several rivers in Southeast Sulawesi including the Laeya River which flow all year round (permanently) have high activity in the river body and upland parts which can affect water quality such as water turbidity. High turbidity comes from material that enters water bodies through running water from nickel and sand mining activities in river bodies. Massive activities can affect the quality of the meat/shellfish fresh weight (Bahtiar *et al.*, 2014). Likewise, the decrease in the quantity of clam meat can be caused by the high activity of catching pokea clams. They have become a resource of important economic value that is utilized by the community not only for consumption in the household scale of fishermen, but also has become food for the community in Southeast Sulawesi, so that several rivers such as the Laeya River (Basri *et al.*, 2019), Pohara River (Bahtiar, 2012) and the Lasolo River (Bahtiar *et al.*, 2016) have been over-exploited. The survey results showed that the landing of pokea clams on the Pohara River in 2012 could reach 155 tons (Bahtiar, 2012).

The results of a literature search showed that research on morphometric (length-weight relationship) and condition factors of pokea clams are still very limited. Similar research was only conducted on the Pohara River in Southeast Sulawesi (Bahtiar *et al.*, 2014), whereas information from this study is important in providing an overview of the management of shellfish resources in Laeya River waters, Southeast Sulawesi. Management of aquatic resources needs to be supported by scientific information availability from various aspects (Bahtiar *et al.*, 2022b; Bahtiar *et al.*, 2022c, Findra *et al.*, 2017; Findra *et al.*, 2020a; Findra *et al.*, 2020b; Taula *et al.*, 2022). The morphometrics of the length-weight relationship can provide information on the form of growth for a moment (Gonçalves *et al.*, 1997), the reproductive cycle (Thippeswamy *et al.*, 2014), and the quality of the aquatic environment, i.e., food availability (Gaspar *et al.*, 2002) and water turbidity (Bahtiar *et al.*, 2014). Likewise, clams condition factors can provide information on meat quality (Hassan *et al.*, 2018; Rahim *et al.*, 2012) and reproductive cycle (Hamli *et al.*, 2019). This study aims to determine the relationship between length and weight and condition of pokea clams in the Laeya River, Southeast Sulawesi, Indonesia.

Materials and Methods

Site and time

The pokea clams samples in this study were collected from the Laeya River, South Konawe Regency, Southeast Sulawesi Province (Figure 1). Sampling was carried out for 10 months from May 2016 to February 2017.

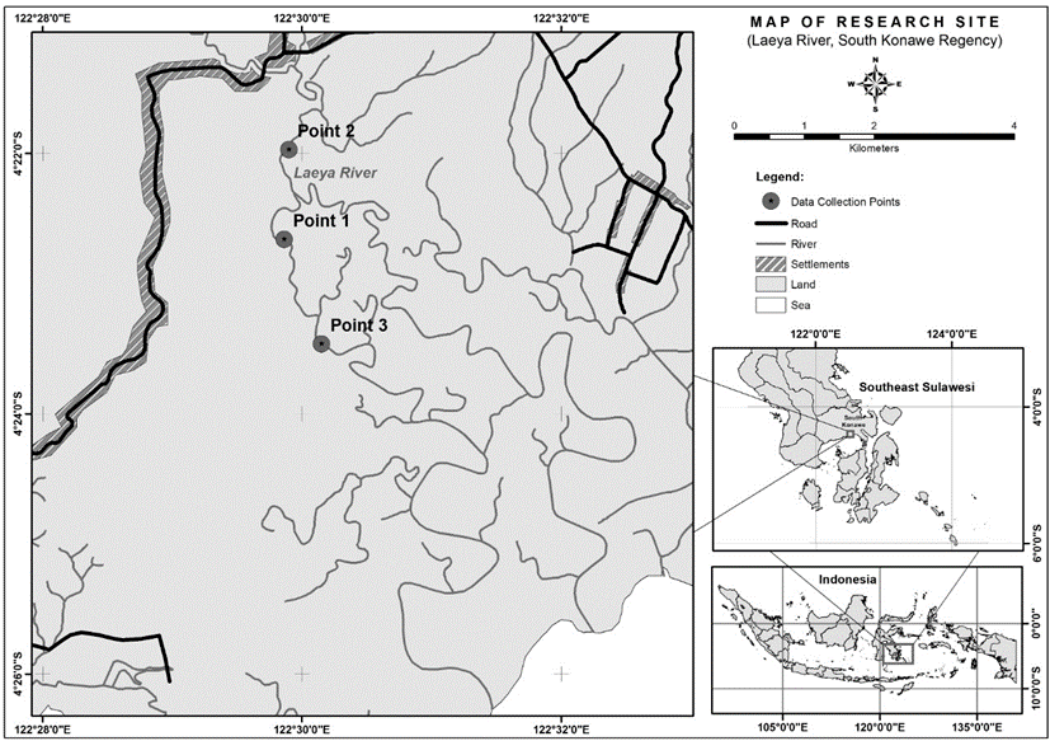


Figure 1. Map of pokea clams sampling locations in the Laeya River, Southeast Sulawesi, Indonesia

Sample collection

The pokea clams were collected from the aquatic substrate using a small shovel (opening width 20 cm) which pulled out as far as ±70 cm. Samples were taken in three parts of the waters and then composited. Samples were brought to the laboratory and then the

shell width were measured as the length of the pokea (Bahtiar *et al.*, 2022a; Figure 2) using calipers and analytical scales with accuracy of 0.05 mm and 0.01 g, respectively. Furthermore, the clams were separated by sex (male and female) which was known from the gonads color. The male is milky white, while the female is yellow to brown. The clams meat was weighed using a analytical scale, then the shell and meat were dried in an oven for 48 hours at 70°C. The shells and dried meat were weighed using an analytical balance with an accuracy of 0.01 and 0.0001 g, respectively.

Figure 2. The length dimensions of pokea clams (Bahtiar *et al.*, 2022a).

Data analysis

The length-weight relationship of pokea clams was analyzed using the following formula by (Afara *et al.*, 2023; Froese, 2006; Gaspar *et al.*, 2002; Machrizal *et al.*, 2019; Perumal *et al.*, 2022; Segun *et al.*, 2022a; Segun *et al.*, 2022b):

$$W = aL^b$$

where W = total weight of pokea clams (g), a and b = growth coefficient, and L = width of the pokea clams shell (cm). The relationship between male and female length with isometric categories (b=3) was analyzed using the t-test (α=0.05; db (n-1).

The condition index of pokea clams in the Laeya River was calculated using the following formula recommended by Walne and Mann (1975):

$$CI = \frac{dtw}{dsw} \times 100$$

where CI = Condition index of pokea clams, dtw = dry tissue weight of pokea clams meat (g), and dsw = dry shell weight of pokea clams (g). Furthermore, the index values were categorized by Rahim *et al.* (2012), i.e., CI<2 = thin; 2-4 = moderate; and CI≥4 = fat. The Man-Whitney test was conducted to determine differences in male and female condition index values based on size and time of observation with (α=0.05).

Results

Length-weight relationship

The length-weight relationship of pokea clams in the Laeya River showed that the b value for male and female were 2.61 and 2.78, respectively; with R^2 values of 0.89 and 0.93, respectively (Figure 3). The results of the t test (α=0.05; db=n-1) show that the b value of male and female pokea is not the same as 3 (b<3). Based on the observation time, it shows that the b value in male and female have increased at the beginning of the study and reached the highest peak in July with values of 3.03 and 2.94 respectively. Furthermore, the value of b continued to decrease and was at the lowest value of b in November with values in males and females of 2.45 and 2.46 respectively (Figure 4).

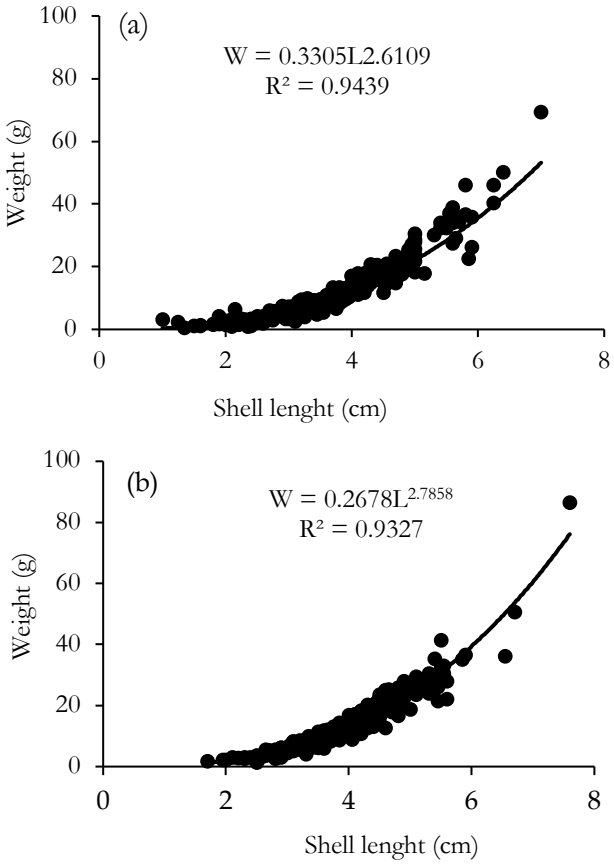


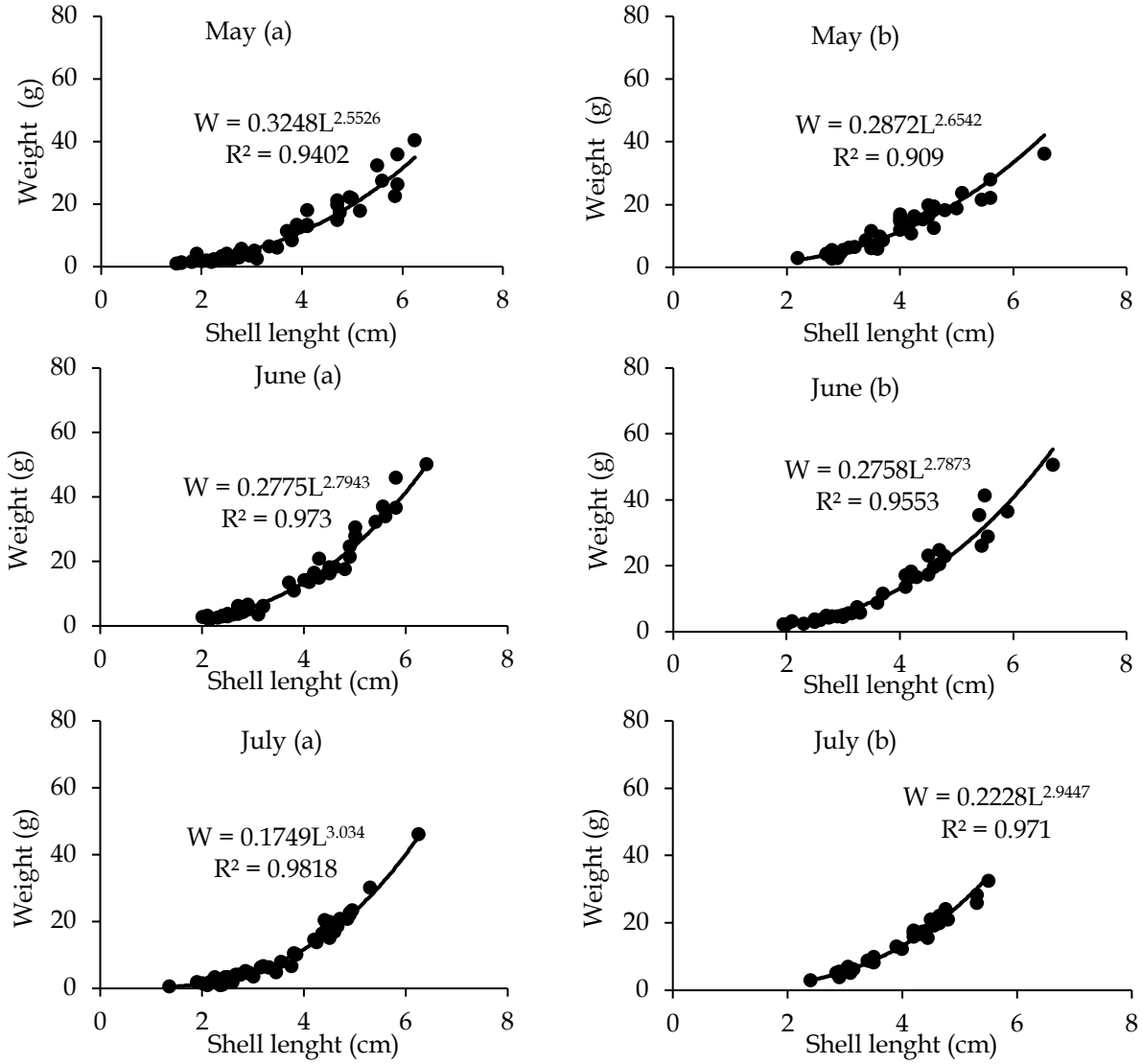
Figure 3. Length-weight relationship of total male (a) and female (b) pokea clams in the Laeya River.

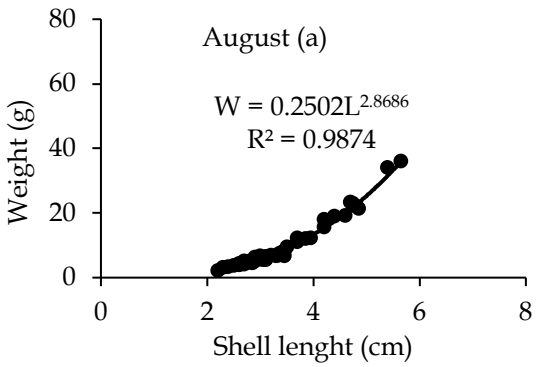
Condition Index

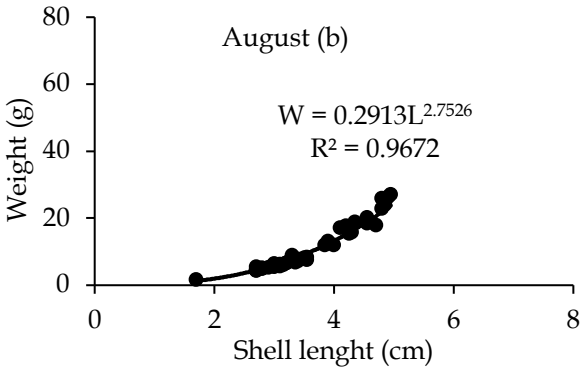
The results of the Mann Whitney test (α=0.05) showed that the condition index values for male and female pokea clams in the Laeya River were not significantly different, although both index values showed different relative values, i.e., 4.7 ± 2.2 and 5.17 ± 2.32, respectively. The results of the Mann Whitney analysis (α=0.05) showed that the condition index values for males and females based on the time

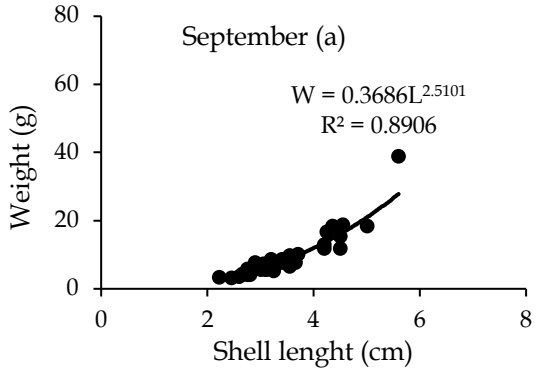
of observation were not significantly different in each month of observation (Figure 5a). The peak condition index occurred in May with values for males and females of 6.00 ± 3.07 and 7.83 ± 2.55, respectively. Furthermore, the condition index value decreased until July with values for males and females (3.58 ± 1.66 and 3.26 ± 1.29, respectively). Male pokea clams experienced an increase in condition index values again in September and October with values of 5.26 ± 1.91 and 5.73 ± 1.22, respectively; while females experienced a decrease with values of 5.99 ± 2.25 and 4.99 ± 1.99, respectively; then the condition index decreased in November (Figure 5b).

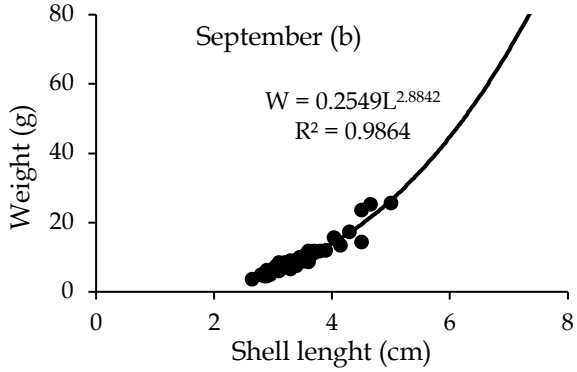
The results of the Mann Whitney analysis (α=0.05) showed that the condition index in males and females based on size did not differ significantly. Condition index values for males and females show a pattern of increasing condition index values with increasing shell size. Shell sizes 1.50-2.00 in males and females have the lowest index values with values of 2.90 ± 1.74 and 3.01 ± 1.59, respectively; and shell sizes 6.01-6.05 with the highest index values for males and females were 8.05 ± 6.41 and 9.12 ± 3.38, respectively (Figure 5c).

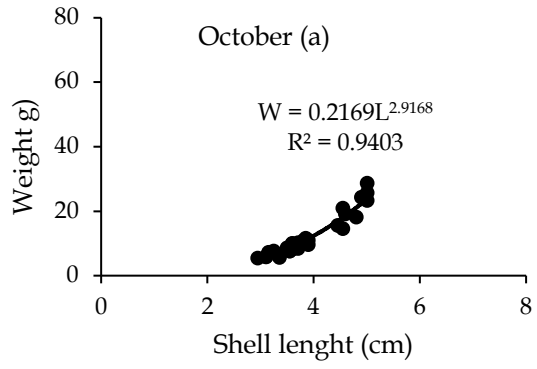


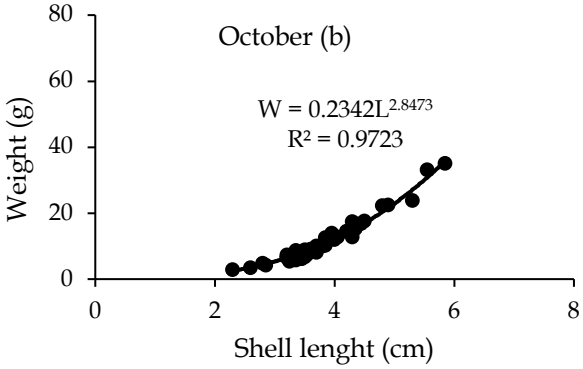

August (a)
W = 0.2502L2.8686
R² = 0.9874
Weight (g)
Shell lenght (cm)

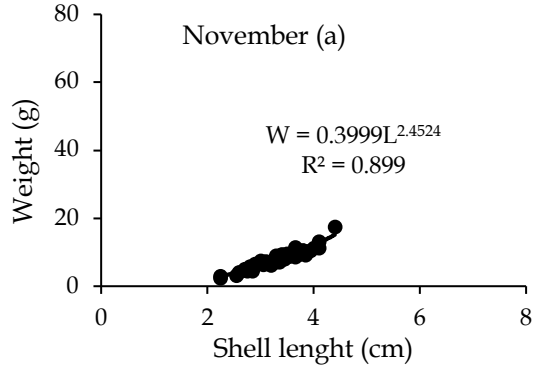

August (b)
W = 0.2913L2.7526
R² = 0.9672
Weight (g)
Shell lenght (cm)

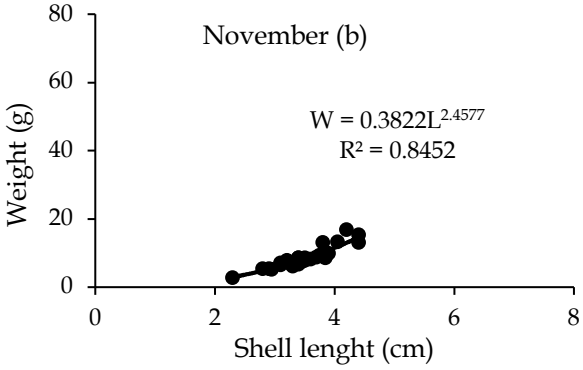

September (a)
W = 0.3686L2.5101
R² = 0.8906
Weight (g)
Shell lenght (cm)

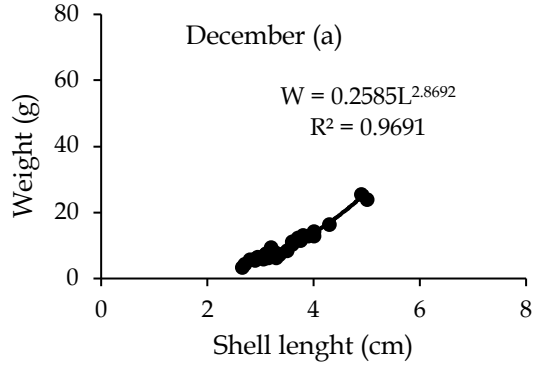

September (b)
W = 0.2549L2.8842
R² = 0.9864
Weight (g)
Shell lenght (cm)

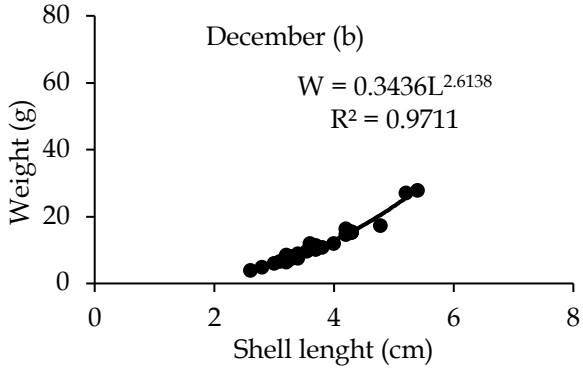

October (a)
W = 0.2169L2.9168
R² = 0.9403
Weight g)
Shell lenght (cm)


October (b)
W = 0.2342L2.8473
R² = 0.9723
Weight (g)
Shell lenght (cm)


November (a)
W = 0.3999L2.4524
R² = 0.899
Weight (g)
Shell lenght (cm)


November (b)
W = 0.3822L2.4577
R² = 0.8452
Weight (g)
Shell lenght (cm)


December (a)
W = 0.2585L2.8692
R² = 0.9691
Weight (g)
Shell lenght (cm)


December (b)
W = 0.3436L2.6138
R² = 0.9711
Weight (g)
Shell lenght (cm)

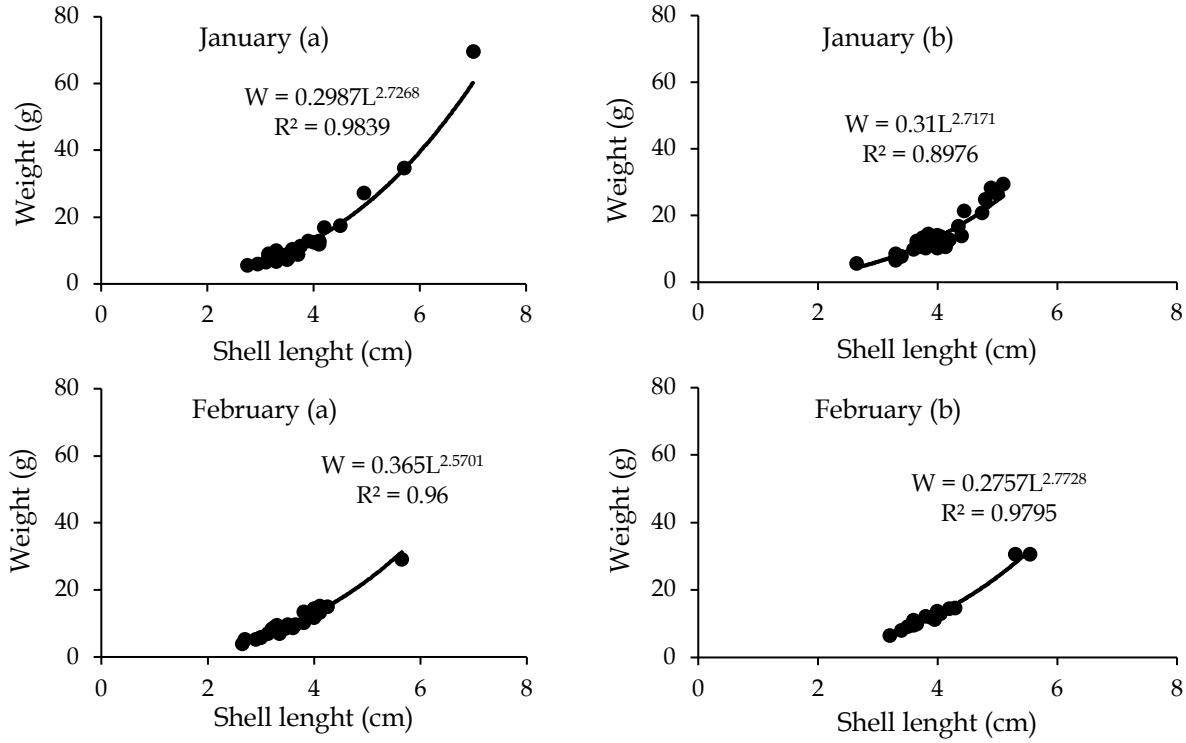


Figure 4. Length-weight relationship of male (a) and female (b) pokea clams based on month in the Laeya River.

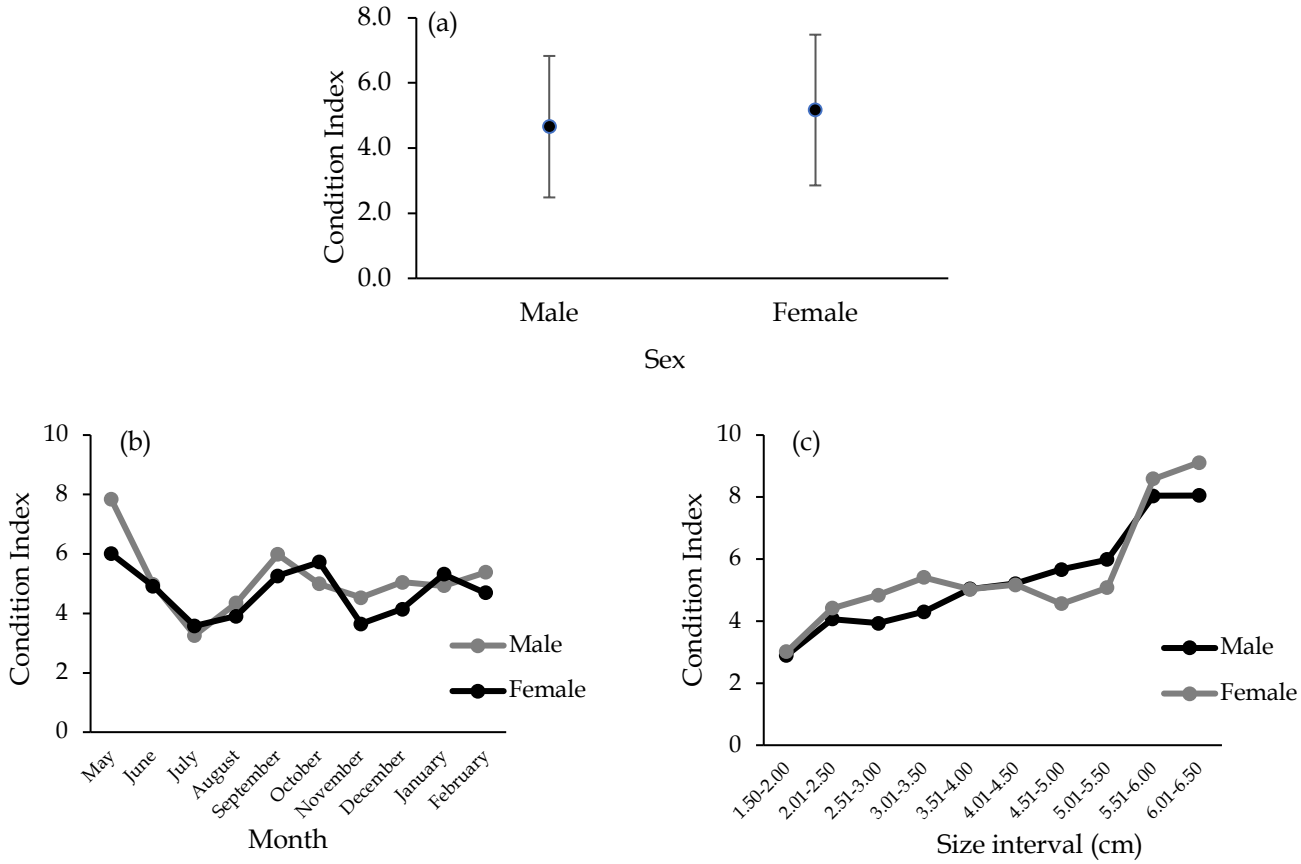


Figure 5. Condition index of male and female pokea clams (a), time of observation (b) and size interval (c) in the Laeya River.

Discussion

Pokea clams in the Laeya River are negative allometric category indicated by the b value for male and female which is 2.61 and 2.78, respectively. In general, the b value of pokea clams in all waters in Southeast Sulawesi (Pohara River and Lasolo River) is very rarely found more than 3.0. The other study

also showed that the b value of pokea clams in the Pohara River range from 1.87 to 2.82 (Bahtiar *et al.*, 2014). Although the b values for male and female are negative allometric category, the trend shows that the b values of female are greater than male. This condition is not much different from the b values both male and female which are found in several places which show the same pattern. The b values for male and female in the Lasolo River ranged from 2.52 and 2.70, respectively (Bahtiar *et al.*, 2018). The b values for male and female in the Pohara River ranged from 2.29 to 2.56, respectively (Bahtiar *et al.*, 2014). This pattern indicates that the weight growth of the length-weight relationship in female pokea clams is greater than male clams. Based on the value of b in both which was never more than 3.0, it indicated that the relationship between the length and weight of pokea clams that were not equal to 3.0. This balance value in pokea clams from the length-weight relationship can be as 2.5. Wilbur and Owen (1964) stated that the isometric condition of the clams is between 2.40-4.50.

The value of b which is not greater than 3.0 in male and female pokea in several river mouths is a casuistic condition that rarely occurs in other shellfish. In general, shellfish showing a value of b is also found at a value greater than 3.0, so that these clams have a growth balance point at a value of 3.0. Several types of shellfish that have a value of ≥ 3.0 such as *Fandora albida*, *Modiolus adriaticus* (Gaspar *et al.*, 2002), *Megapitaria squalida* (Schweers *et al.*, 2006), *Polymesoda erosa* of 3.12 (Elvira and Jumawan, 2017).

In general, the value of b can be various based on the time of observation (Tirado and Salas, 1998), but the value of b is a negative allometric condition except in July is in an isometric pattern (2.94 and 3.03). A low b value for pokea clams in the Laeya River throughout all months is an indication/prove that the pokea clam is one of clams types that cannot reach above 3.0 or the isometric value is at a value of 3.0.

The quantity of pokea meat in Laeya River can be expressed from the condition index value (Hassan *et al.*, 2018). The condition index of pokea clams is fat category (Rahim *et al.*, 2012). The condition index of pokea in Laeya River was relatively higher than that pokea in the Lasolo River, namely 3.98 ± 1.44 and 4.27 ± 1.52 (Bahtiar *et al.*, 2018).

The high index of pokea clam in the Laeya River is caused by several conditions, i.e., 1) pokea clam is a type of clam that occupies the bottom of estuary waters which is rich in nutrients as food for shellfish; 2) pokea clam has high productivity in converting food resources both in the form of plankton and detritus (Bahtiar, 2012) through the mechanism of sweeping food on the bottom floor of the waters and filtering food (Arapov *et al.*, 2010; Vaughn *et al.*, 2008); 3) shell thickness has an effect on changes in condition index values (Duinker *et al.*, 2008). Pokea clams have thicker flesh and relatively thinner shells, thus contributing a relatively large condition index value.

In general, the condition index increased with increasing shell size. The same is shown in other shellfish such as *Geloina expansa* in Kendari Bay (Bahtiar *et al.*, 2023). However, unlike the pokea clams in the Lasolo River, the highest was at 5.50 cm and the condition index decreased at larger sizes (Bahtiar *et al.*, 2018).

Changes in the condition index temporally indicate changes in clams gonadal maturity (Hamli *et al.*, 2019). The increase in the condition index of pokea clams in Laeya River experienced an increase in gonadal maturity in March and April (high condition index) and then the pokea clams experienced peak spawning marked by a sharp condition index in July (low condition index). The condition index was at relatively stable values (female) and fluctuated low when the clams were after spawning and the next partial spawning and inactivity phase occurred in September-February (Bahtiar *et al.*, 2018).

Conclusions

The growth of pokea clams in the Laeya River was negative allometric pattern. The condition index of clams was in the fat category and had peak spawning in July and experienced partial spawning in September-February.

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