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Growth pattern and condition index of exploited *Meretrix meretrix* (Linnaeus, 1758) at Kambu River estuary, Southeast Sulawesi, Indonesia

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ABSTRACT

Meretrix meretrix is one of the economical shellfish that has been exploited in Kendari Bay, Indonesia. Several studies have been done, but its growth pattern and condition index are not fully known. This study aims to determine its growth pattern and condition index at the Kambu River estuary, Kendari Bay. This research was conducted for 6 months from August 2021 to January 2022. Clams were collected using a rake, cleaned, and brought to the laboratory to be measured for length and weight using calipers and scales with an accuracy of 0.1 mm and 0.01g, respectively. Furthermore, the clam meat was dried using an oven and weighed. Data on growth and condition index were analyzed using simple regression and the Mann-Whitney test, respectively. The results showed that the growth of M. meretrix was in negative allometric conditions, with b values in males and females in the range of 2.20-3.00 and 1.86-2.73, respectively. The condition index of male and female clam ranged from 1.86-2.62 and 1.66-2.41, respectively, and differed significantly by month. The results of the Mann-Whitney test on clam showed that there was no significant difference between August-November and December-January. In conclusion, male and female clam had relatively different patterns based on the observation period, while the condition index was in the skinny and medium category

Introduction

Meretrix meretrix clam is commonly known as Asiatic hard clam or hard clam or white clam (Sienes *et al.*, 2018). This clam comes from the Veneridae family with various types of which in world waters there are approximately 16 species of the genus *Meretrix*, i.e., *M. meretrix, M. lamarckii, M. tigris, M. planisulcata, M. subtrigona, M. marisarabicum, M. astricta, M. aurora, M. attenuate, M. casta, M. morphine, M. lusoria, M. lyrata, M. petechialis, M. vestita,* and *M. taiwanica* (Huber, 2010; WoRMS, 2023). Veneridae clams are the most common bivalves found which are widely distributed in the Indo-West Pacific (Sienes *et al.*, 2018). One type of Veneridae clam whose distribution is found in almost all coastal waters in Indonesia comes from the *M. meretrix* species (Akhmadi and Trijoko, 2016; Riswanda *et al.*, 2014; Wiharyanto *et al.*, 2013). Ecologically, they are found in intertidal waters (Desrita *et al.*, 2019), estuaries in mangrove ecosystems, and bays (Amin *et al.*, 2009; Bahtiar *et al.*, 2022; Chowdhury *et al.*, 2019; Desrita *et al.*, 2019; Kantharajan *et al.*, 2017; Rohmah and Muhsoni, 2020) to open coastal waters which are characterized by more sand and less muddy bottom. In general, this clam is a resource with economic value that has properties and benefits (Apriandi *et al.*, 2021; Ginting *et al.*, 2017; Hamli *et al.*, 2011; Susetya *et al.*, 2018) so that it is used as a food source with nutrients (Chen *et al.*, 2012) and traditional medicine in several countries such as China (Chen *et al.*, 2012; Tabakaeva *et al.*, 2018; Xie *et al.*, 2012). *M. meretrix* contains 15 amino acids consisting of 9 essential amino acids and 6 non-essential amino acids (Abdullah *et al.*, 2017). Empirically, the clams are

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believed to increase stamina, lower blood pressure and can treat hepatitis. These clams have immune-modulatory and anti-cancer activities (Xie *et al.*, 2012).

This clam is very popular with the people around Kendari Bay and in several places so that people take it which tends to exploit it without regard to its sustainability in nature (Bahtiar, Pratama, *et al.*, 2022; Desrita *et al.*, 2019). This can be seen from the size of the shells caught of various sizes. This condition has an impact on the population pressure, especially the decrease in the quality and quantity of the clam which can be seen from length-weight relationship and condition index of the clam (Bahtiar *et al.*, 2014, 2023).

Several studies had been conducted regarding the morphometrics and condition factors of clam in the same species and genus in several waters, i.e., Sarawak waters, Malaysia (Hamli *et al.*, 2011), Tanjung waters, Makassar (Indraswari *et al.*, 2014), in Bancaran waters, Madura (Ambarwati *et al.*, 2021), Tanjung Balai waters, North Sumatra (Desrita *et al.*, 2019), Mumbai waters, India (Sharma *et al.*, 2005), Muara Vellar, Uppanar, and Pennaiyar estuaries along the coast Tamilnadu (Srilatha *et al.*, 2015). However, similar studies have not been carried out in the waters of the Kambu River estuary, Kendari Bay, while studies on the length-weight relationship and condition index are important for predicting recruitment, estimating stocks, and solving taxonomic problems (Octavina *et al.*, 2015; Bahtiar *et al.*, 2022; Bahtiar *et al.*, 2023; Findra *et al.*, 2017, 2020, 2023; Sharma *et al.*, 2005), and identified clams gonadal development (Bahtiar, Purnama, *et al.*, 2022; Rahim *et al.*, 2012). Therefore, this study aims to determine the growth pattern of exploited *M. meretrix* at the Kambu River estuary, Southeast Sulawesi, Indonesia.

Materials and Methods

Sample collection

The study was carried out from August 2021 to January 2022 at the mouth of the Kambu River, Kendari Bay, Southeast Sulawesi (Figure 1). Clam samples were collected using a rake by digging the substrate as deep as 20 cm. The clams were cleaned from the substrate and their length and weight were measured in the laboratory of the Faculty of Fisheries and Marine Sciences, Halu Oleo University, Kendari. The length and weight were measured using a caliper with an accuracy of 0.1 mm and a digital scale with an accuracy of 0.01 g.

Data analysis

The growth of *M. meretrix* was calculated using a simple linear regression suggested by Gaspar *et al.* (2002), Afara *et al.* (2023), Bahtiar *et al.* (2023), and Findra *et al.* (2023) as follows:

$$W = aL^b$$

where: W = total weight of clam (g), a and b = constants, L = shell length of clam (cm).

Condition index for *M. meretrix* were calculated using equation suggested by Marcado-Silva (2005) and Bahtiar *et al.* (2023) as follows:

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

where: CI = condition index of clams, dtw = dry tissue weight of clams meat (g), and dsw = dry shell weight of clams (g). If the CI value <2, the clams are classified as thin; if 2≥CI≤4, the clams are classified as medium; and if CI≥4, the clam is classified as fat (Rahim *et al.*, 2012). The condition index value was statistically tested using the Mann-Whitney test to see its significance.

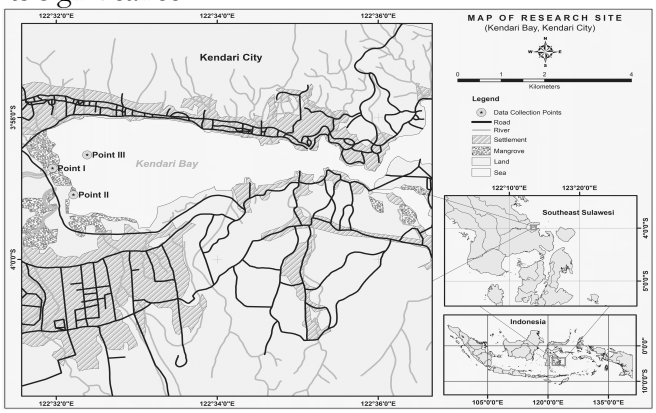

Figure 1. Research site of *M. meretrix* at Kambu River estuary, Kendari Bay.

Results

The growth pattern of male *M. meretrix* was at b values, namely 2.20-3.00 and for females with b values ranging from 1.86 to 2.73. In general, male and female clams are at a value below 3.0. Male clams showed a pattern that increased until December and then decreased, while the b value of female clams relatively decreased until the end of December and January (Figure 2).

Male and female *M. meretrix* clam had a condition index ranging from 1.86-2.62 and 1.66-2.41, respectively. The condition index of male tends to decrease from small to large size of samples, while the female mussels are relatively the same based on size class. The results of the Mann-Whitney test on clam showed no different values based on size class and sex (Figure 3a).

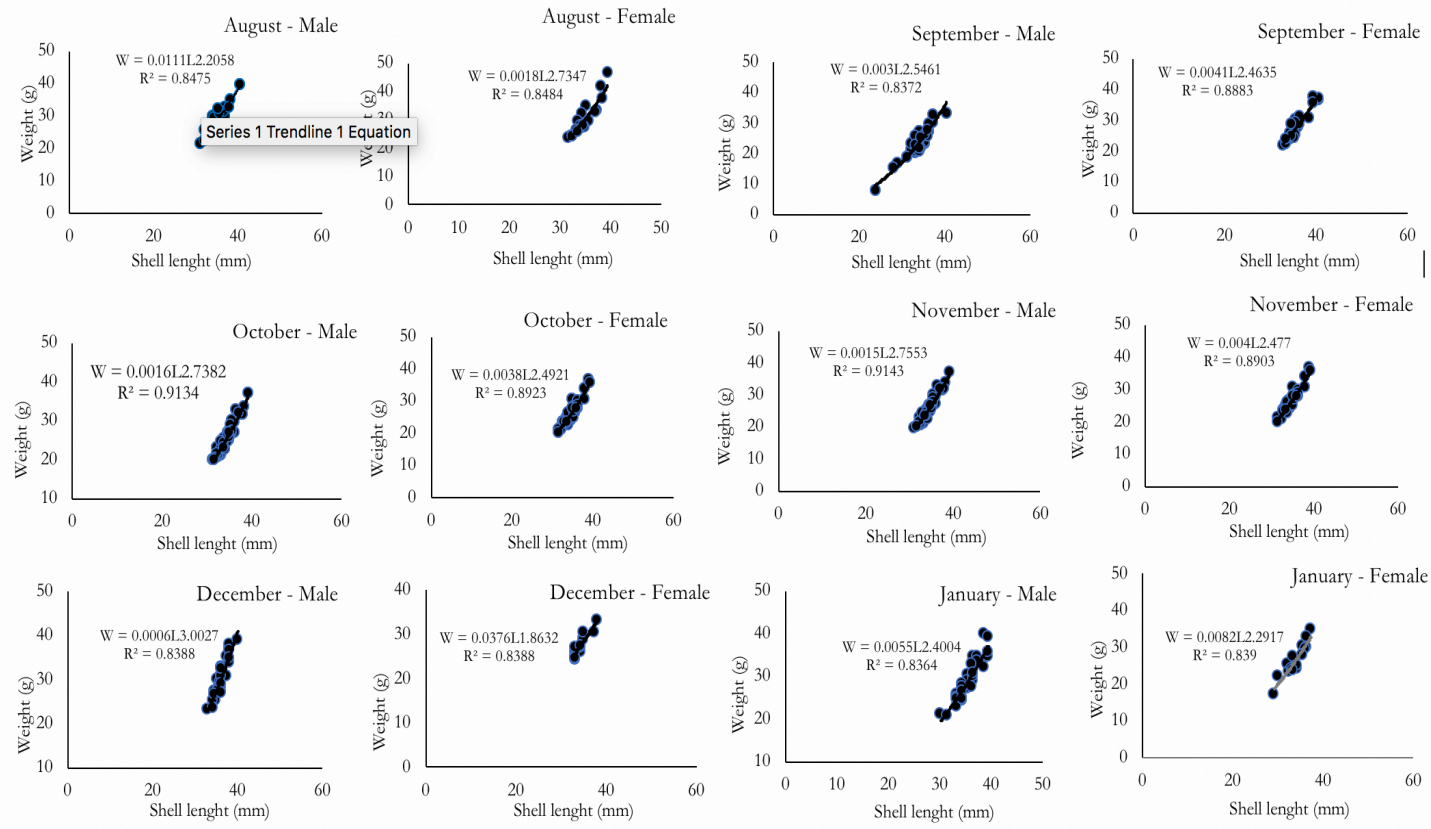

Figure 2. Length-weight relationship of *M. meretrix* at the Kambu River estuary, Kendari Bay.

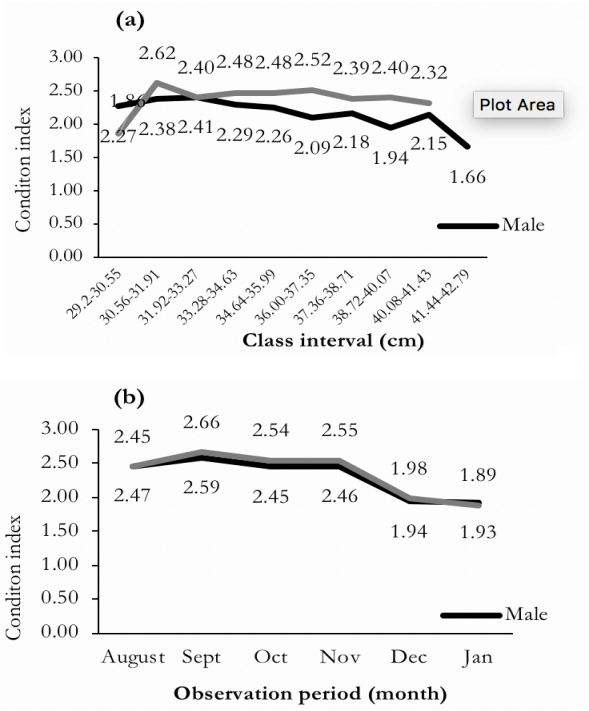

Figure 3. Condition index of *M. meretrix* based on size (a) and observation period (b).

The condition index of males and females based on the observation period tended to decrease until the end of the study. The results of the Mann-Whitney test showed that August-November was different with December-January (Figure 3b).

Discussion

M. meretrix at the Kambu River estuary for males and females were at a value of b which was generally below 3.0. This could also mean that the clam had a negative allometric growth pattern, even though the males in December had an isometric pattern. The growth pattern of clams in the Kambu River is relatively similar to same clam in Tanjung Balai, North Sumatra, which are in the range of b values, i.e., 2.16-2.78 (Desrita *et al.*, 2019) and 1.67-2.86 in the waters of Mumbai, India (Sharma *et al.*, 2005).

Male and female had relatively different patterns based on the period of observation indicated by the movement of b values. The male clams increased until December, while the female clams relatively decreased until the end of December and January. But in general, the growth pattern of clams were still in a negative allometric condition. Changes in the b value of clam can vary temporally (Ngor *et al.*, 2018) which depends on several circumstances, i.e.: 1) an increase in the value of b is related to the development of gonadal maturity (Thippeswamy *et al.*, 2014; Türkmen *et al.*, 2002). Accumulation of yolk content (vitellogenesis) in the developmental phase up to the peak phase of gonadal maturity is followed by an increase in body weight. Otherwise, the spawning phase of the clam which releases the eggs leaving the body of the clam will be followed by a decrease in the total weight of the clam (Bahtiar, 2017); The optimum water quality for clam growth is indicated by the high availability of food in the waters (Gaspar *et al.*, 2002). In general, clams are filter feeder animals that have a high ability to absorb food in the waters and convert it into body tissues. High food availability will be followed by an increase in the b value of clam, and low food availability has implications for low clam b values (Bahtiar *et al.*, 2014); 3) a decrease in the value of b is also caused by high exploitation of clams (Petetta *et al.*, 2019). It also was shown on *Batissa violacea* clam which have low b values in areas of high exploitation (Bahtiar *et al.*, 2014).

Condition index and condition factors can be used as instruments in assessing the health of shellfish and the development of gonadal maturity (Hamli *et al.*, 2017; Lagade *et al.*, 2014). The condition index values for male and female clam were relatively similar although there was a tendency for males to decrease as the size of the clams increased. The clam condition index which is in the range of 1.66-2.62 is in the thin and medium category (Hassan *et al.*, 2018). The condition index value of *M. meretrix* at the Kambu River estuary was relatively different from clam in the same genus, i.e., *M. lyrata* found in Kuching waters Sarawak, which were in the medium to fat category with values ranging from 2.47 ± 0.46 to 4.26 ± 0.42. The condition index varies depending on a number of things, i.e.: 1) morphometrics/body shape of each species (Micklem *et al.*, 2016), one of which is influenced by the thickness of the clam), the availability of food differs in each waters (Krampah *et al.*, 2016).

The condition index of males and females has relatively the same pattern based on the observation period. The condition index experienced a sharp downward trend at the end of the observation (December-January). This change in trend is closely related to the reproductive cycle of clams. Sawant and Mohite (2013) reported that *M. meretrix* had a long spawning period. It spawns from September to January on the coast of Maharashta, India. These clams mature and were followed by partial spawning until November. Different things were shown by clams in the same genus *M. lyrata* which had the highest condition index occurring in May, October, and March simultaneously with the peak of maturity and having the lowest condition index in September, November, and April when the clam population after spawning and moved into a resting phase (Hamli *et al.*, 2017). The condition index in each area is relatively different according to the reproduction pattern of clam. The increase in the condition index value occurs at the beginning of the development of gonad maturity, then the highest condition index occurs at peak maturity and decreases along with the spawning of the clam (Adjei-Boateng and Wilson, 2013; Hamli *et al.*, 2017).

Conclusions

Male and female *M. meretrix* clam at the Kambu River estuary had relatively different pattern based on the observation period, but the generally growth pattern was still in negative allometric conditions. The condition index showed that the clams were in the skinny and medium category.

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