***Original Research Article***

**Biometric Assessment of the Growth Condition of Asian-Moon Scallop (*Amusium pleuronectes* Linnaeus, 1758) from the waters of Makassar Strait, Indonesia**

**ABSTRACT**

Asian-moon scallop are a commodity with high economic value and are widely used by coastal communities. Intensive use is thought to have caused changes in the population of this shellfish in nature. This study aims to analyze biometric characteristics to obtain information on growth patterns, condition factors, and condition indices of Asian-moon scallop (*Amusium pleuronectes*) in the waters of the Makassar Strait, Indonesia. The study was conducted using a survey approach with a purposive sampling method for collecting shellfish samples. Samples were taken at three stations with 15 samples per station, resulting in a total of 45 Asian-moon scallop samples. The results of the study showed that the biometric characteristics of the Asian-moon scallop found had a negative allometric growth pattern, shell length ranging from 50.0-72.5 mm (59.79 ± 5.72 mm, total weight ranging from 7.0-22.9 g (14.96 ± 3.649 g), and meat weight ranging from 3.0-11 g (6.36 ± 2.069 g). The condition factor (CF) ranged from 4.73-9.21 (6.933 ± 0.918) and the condition index (CI) ranged from 27.27-57.14 (42.1850 ± 6.71652). Based on the negative allometric growth pattern and the comparison between the condition factor and the condition index, it is an indicator that there has been environmental pressure and anthropogenic activities on scallop resources..

Keywords: Condition Factors; condition Index; Asian-moon scallop, Growth Pattern; Makassar Strait

1. **INTRODUCTION**

The Makassar Strait is a strategic waterway connecting the Pacific Ocean with the Indian Ocean and has a high biodiversity wealth (Boussaha et al 2024). One species that plays an important role in this aquatic ecosystem is the Asian-moon scallop (Amusium pleuronectes), also known as the Asian moon scallop. This shellfish generally lives on the bottom of muddy or sandy waters at a depth of 10-100 m (Hardianto 2024).

 Asian-moon scallop have ecological value as filter feeders that help maintain water quality by filtering plankton and organic particles (Sari *et al* 2022). Asian-moon scallop are economically a major commodity for coastal communities (Agustini *et al* 2011). In addition, Asian-moon scallop shells have the potential as raw materials in the biomedical industry, especially in the manufacture of bone and dental implants, thanks to their calcium carbonate and hydroxyapatite content (Sari *et al* 2022). Asian-moon scallop also support improving the welfare of coastal communities who depend on this commodity for their livelihoods (Buban et al 2019).

Several studies of Asian-moon scallop that have been conducted by previous researchers include Sari *et al*. (2022) who focused on studying the characteristics of hydroxyapatite in Asian-moon scallop shells on a laboratory scale. Budiyati *et al*. (2024) studied nitrogen levels due to eutrophication and its impact on scallop growth patterns in the waters of the Makassar Strait and Bone Bay. Suratno *et al*. (2020) studied the condition index of Asian-moon scallop during the rainy season from Semarang waters. Hardianto (2024) studied genetic variation in scallops in several waters in Indonesia to detect adaptation to environmental stress. Hafid *et al.* (2024) identified microplastics in Asian-moon scallop in the waters of the Makassar Strait.

One of the main habitats of scallops in Indonesia is the waters of Pangkajene and Kepulauan Regency located in the Makassar Strait. Research on the biometrics of Asian-moon scallop in the waters of the Makassar Strait, especially in Pangkajene and Kepulauan, is still very limited if we refer to research that has been conducted by previous researchers. The limitations are attempted to be completed by preparing basic scientific information through analysis of the biometric characteristics of the Asian-moon scallop related to shell length, total weight, and shell thickness to obtain information related to growth patterns, condition factors, and condition indexes of Asian-moon scallop. Biometrics are not just morphological data but are an important foundation in assessing the health of natural Asian-moon scallop stocks, designing fishing regulations related to the minimum size that can be harvested and conservation in an effort to realize sustainable utilization based on science based on condition index values ​​that are suitable for routine biomonitoring. The information obtained from this study is expected to be basic information in the management and conservation of sustainable Asian-moon scallop resources,

1. **MATERIALS AND METHODS**

**2.1 Time and place of research**

This research was conducted from February to May 2025 in the waters of Pangkajene and Kepulauan Regency, located in the Makassar Strait, Indonesia. The research location was selected based on the presence of a population of scallops (Amusium pleuronectes) which has a habitat with relatively similar conditions, namely muddy sand and relatively the same brightness. Sampling was carried out at three stations with coordinates Station 1 at position S: 4°57’14.4”; E: 119°21’58.4”, Station 2 at position S: 4°57’10.4”; E: 119°21’48.5”, and Station 3 at position S: 4°58’21.4”; E: 119°21’57.0”.

**2.2 Research Procedures**

This study used a purposive sampling method at three stations. At each station, 15 Asian-moon scallop samples were taken three times, so that the total samples collected were 45 individuals. The depth of the waters where the Asian-moon scallop samples were taken averaged 3.5 m. Measurement of biometric parameters included shell length, shell thickness, total weight, and meat weight. The length and thickness of the shell were measured using a digital caliper with an accuracy of 0.01 mm, while the total weight and meat weight were measured using a precision scale with an accuracy of 0.01 grams. The data obtained were then analyzed to obtain information on growth patterns, condition factors, and condition indexes of Asian-moon scallop.

**2.3 Data Analysis**

The growth pattern of Asian-moon scallop was analyzed using the formula model from Effendi (2002):

Where:

W = total weight (g),

L = shell length (mm),

a = growth constant, and

b = growth exponent indicating the type of growth (isometric if b=3, allometric if b ≠ 3).

Condition Factor (K) is calculated to assess the health of mussels using the formula proposed by Ahirwal *et al* (2025):

Where::

K = Condition factor

W = total weight (g)

L = shell length (cm)

b = growth exponent from Length-weight analysis

The Condition Index (CI) is used to assess the physiological condition of shellfish calculated using the formula applied by Supeni (2021).

Where:

Description:

CI = condition index (%)

W meat = weight of scallop meat (g)

W total = total weight including shell (g)

1. **RESULT AND DISCUSSION**

**3.1 Biometric Characteristics of Asian-moon scallop**

The results of measurements of the biometrics of Asian-moon scallop (*Amusium pleuronectes*) taken from the waters of the Makassar Strait are shown in Table 1. The range of shell lengths indicates the presence of individuals in various size classes ranging from young adults to full adults, which illustrates the sustainability of the population in the study area (Satriawan et al 2024). Shell thickness shows that most individuals have fairly uniform shell thickness. This thickness is an important parameter in determining the resistance of shells to physical conditions in the aquatic environment such as waves and interactions with predators (Berthou *et al* 2009). The variation in Asian-moon scallop weight indicates differences in physiological condition and meat filling levels between individuals (Buban *et al* 2019). The ratio of meat weight to total weight can also be an indicator of growth efficiency and population health (Hari *et al* 2022). This variation also reflects a heterogeneous population structure, possibly caused by differences in age, food availability, and habitat quality (Singh, 2017). Budiyati *et al*. (2025) stated that the relationship between length and weight with negative allometric growth patterns has an impact on low genetic homogeneity. Khairiyah *et al*. (2020) revealed that the condition index is effective as a biomarker indicator for habitat quality management.

Table 1. Biometric characteristics of Asian-moon scallop from Pangkajene and Kepulauan waters



Ernawati *et al*. (2011) obtained a shell length of 62.3 ± 6.1 mm and a total weight of 15.8 ± 4.2 g in Tegal waters, Indonesia. Buban et al. (2019) found a shell length of 61.7 ± 5.4 mm and a total weight of 16.2 ± 3.8 g in a population in the Philippines. Derbali *et al*. (2019) reported slightly lower data on Pinctada radiata in Gabes Bay, Tunisia with a length of 58.9 ± 4.9 mm and a weight of 14.1 ± 3.2 g. Agustini *et al.* (2011) recorded a length range of 55–75 mm with a weight of 12–23 g in Central Java waters, indicating that the biometric values ​​in this study are still within the reasonable range for tropical environments.

The findings of Ernawati et al. (2011) in Tegal waters which also showed variations in length and weight in Asian-moon scallop, were interpreted as a physiological response to environmental fluctuations. Variations in biometric data are likely influenced by differences in environmental conditions such as water quality, substrate, and food availability. Boussaha et al. (2024), stated that stable habitat and sufficient resources are the main keys to the survival of mollusks.

Asian-moon scallop (*Amusium pleuronectes*) in the waters of Pangkajene and the Islands have biometric characteristics of varying shell size and thickness as indicators of strong physical conditions to protect the shells from predator pressure and environmental changes. The total weight and meat weight achieved are indications of sufficient energy reserves to carry out physiological and reproductive functions, and are good biomass potential in terms of economy. Meat weight is also an indicator that this species has potential economic value, but periodic environmental monitoring is still needed to ensure the sustainability of its productivity.

3.2 Asian-moon scallop Growth Pattern

The growth pattern of Asian-moon scallop in the Makassar Strait shows a negative allometric pattern with a b value of 2.4011. This shows that the increase in shell length is not proportional to the increase in total weight, with a relationship of W = 0.0008L2,4011. This negative allometric growth pattern indicates that the weight of the Asian-moon scallop increases more slowly than the length of the shell. This is thought to be due to environmental pressure and very intensive anthropogenic activities in the research area. Other researchers argue that this negative allometric growth pattern is associated with sub-optimal environmental conditions or the presence of ecological pressure (Effendi 2002; Boussaha et al. 2024). Satriawan *et al*. (2024) also found a negative allometric growth pattern with a b value of 2.35 in Asian-moon scallop in Kendal, Central Java, which was caused by limited food and decreased water quality due to anthropogenic activities.

Derbali et al. (2019) also found a negative allometric growth pattern in Chlamys varia in Gabès Bay, Tunisia. This is associated with habitat degradation due to eutrophication and high sedimentation. Maulana et al. (2023) who studied Asian-moon scallop in Dumai waters, Riau also found a negative allometric growth pattern with a b value of 2.38, and concluded that growth was hampered by seasonal salinity fluctuations.

The coefficient of determination (R2) of 0.7752 indicates that the relationship between shell length and total weight is relatively strong. This value explains that 77.52% of the variation in shell weight can be explained by shell length, while the remaining 22.48% is influenced by external factors related to the environmental conditions where the Asian-moon scallop live.

Boussaha *et al.* (2024) emphasized that environmental quality contributes to the growth pattern of molluscs. This phenomenon is often associated with suboptimal environmental conditions that limit energy allocation for weight growth, as explained by Derbali *et al.* (2019) that environmental stress such as pollution and habitat degradation can reduce metabolic and reproductive efficiency, thus negatively impacting growth. Supeni *et al*. (2021) stated that variations in length and weight are also influenced by the presence of nutrients in waters and anthropogenic factors that affect environmental quality.



Figure 1. Relationship between length and weight of Asian-moon scallop

* 1. Condition Factor (CF) and Condition Index (CI)

Condition factor (CF) and condition index (CI) of Asian-moon scallop (*Amusium pleuronectes*) obtained during the study are shown in Table 2. Higher CF values ​​indicate better physical condition, meaning the Asian-moon scallop have sufficient energy reserves to support physiological functions and reproductive processes. Buban *et al.* (2019, 2021) also reported a CF value of 7.5 ± 1.0 for a similar Asian-moon scallop population in Philippine waters that are relatively free from pollution and environmental disturbances. Ernawati et al. (2011) recorded a CF value of 6.85 ± 0.75 in a Asian-moon scallop population in Tegal waters, Indonesia, which is almost similar to the findings of this study.

The CF value reflects the efficiency of energy conversion to body structure, and low values ​​indicate stress or nutritional deficiencies (Buban *et al.* 2021; Mohammad & Bahram 2015). Buban et al. (2019) found a CF value of 7.5 ± 1.0 in the Bractechlamys vexillum population, indicating stable environmental conditions. Ernawati et al. (2011) obtained a CF value of 6.85 ± 0.75 in Tegal waters, Central Java. CF values ​​can fluctuate based on season and geographic location.

Rahmawati et al. (2021) obtained a CF value of 5.8 ± 0.6 in Balikpapan coastal waters polluted by domestic and industrial waste. Meanwhile, Widiastuti & Budiharjo (2023) found an increase in CF values ​​in the dry season compared to the rainy season in Karimunjawa waters due to increased primary productivity and salinity stability. This difference in CF values ​​indicates that environmental quality, especially the level of pollution and availability of food resources, greatly affects the physiological conditions and energy balance of Asian-moon scallop.

The slightly lower CF value in the Makassar Strait compared to the Philippines is likely due to variations in environmental quality, substrate type and habitat depth, pollution levels, and food availability. If these conditions are unstable, it can cause environmental stress that has the potential to reduce the physiological condition of individuals. Buban et al. (2021) stated that the low CF value was due to less supportive environmental conditions and the potential for biological stress.

Table 2. Condition factor and condition index values ​​of Asian-moon scallop



Higher CI values ​​indicate that the mussels are in better physiological condition, having sufficient energy reserves to maintain metabolic activity and support growth and reproduction. Conversely, mussels with lower CI values ​​indicate possible physiological stress or resource limitations affecting their condition.

Ernawati *et al*. (2011) found a CI value of 44.0 ± 5.8 in the population in Tegal waters, while Derbali et al. (2019) found a CI value of 39.5 ± 7.2 in the mollusk population in Gabes Bay, Tunisia. The difference in CI values ​​is thought to be related to physiological responses influenced by different environmental conditions. Variations in CI indicate that some individuals may experience stress due to food limitations that impact their energy reserves and physiology (Derbali *et al* 2019).

The condition index (CI) value in this study shows the diversity of individual physiological status. The CI value reflects the energy reserves available in the soft tissue of the mussel, and can be used as an indicator of population sustainability (Suratno *et al*. 2020). Boussaha *et al*. (2024) emphasized the importance of CI as a predictor of mussel population health in the face of climate change related to ocean warming and decreasing dissolved oxygen levels.

The CI value in this study is higher than the CI value reported by Hafid *et al*. (2024) from the Makassar Strait waters contaminated with microplastics of 39.8 ± 4.9, and close to the optimal value by Hold (2021) in the South Atlantic waters for Pecten maximus under controlled conditions. This information explains that despite local environmental pressures, the Asian-moon scallop population in this study area still maintains relatively good physiological conditions.

The relationship between length, weight, CF, and CI in this study reflects a partial balance between physiological needs and the ability of mussels to adapt to their environmental conditions. The combination of these three parameters shows that although Asian-moon scallop in the Makassar Strait have growth potential, external factors remain a constraint that affects biomass optimization.

As a practical implication, regular monitoring of biometric and physiological parameters is highly recommended for early detection of changes in environmental quality. Habitat conservation efforts, pollution reduction, and sustainable fishing management are key to maintaining the productivity and sustainability of Asian-moon scallop populations in tropical waters of Indonesia.

 **CONCLUSIONS**

Asian-moon scallop (*Amusium pleuronectes*) in the Makassar Strait waters show a negative allometric growth pattern that weight growth is not proportional to the increase in shell length. Biometric parameters show variations in size and physical condition of the population with an average shell length of 59.79 ± 5.72 mm and a total weight of 14.96 ± 3.65 g. The condition factor value of 6.9329 ± 0.91851 and the condition index of 42.185 ± 6.716 indicate that the physical and physiological condition of the population is generally good, although there are variations that indicate pressure as a result of anthropogenic activities and environmental quality conditions.

.Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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