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An Investigation on the Morphometric Characteristics of the White-Spotted Rabbitfish (*Siganus canaliculatus* Park, 1797) in the Small Semi-Enclosed Bay Based on Truss Morphometric Methods

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ABSTRACT

The truss morphometric method is increasingly used to study fish's morphometric characteristics between populations in different habitats. The white-spotted rabbitfish (*Siganus canaliculatus*) is one of the herbivorous fish associated with a variety of habitats of seagrass meadows adapted to its life cycle. This study aimed to compare the morphometric characteristics of *S. canaliculatus* populations among different habitats of seagrass meadows in Inner Ambon Bay (IAB). Fifty fish samples were measured for morphometric characters using the truss morphometric method taken from four observation stations. Principal component analysis and cluster analysis were used to compare morphometric characteristics between habitats, while the distribution of individuals within and between populations was assessed using canonical discriminant analysis. The results of the PCA analysis obtained three population groupings based on a comparison of morphometric characteristics, with two critical distinguishing characters between populations, namely:the upper end of the mouth to the end of the cranial (A1), and the end of the cranial to the beginning of the dorsal fin (B1). Differences in tidal current distribution patterns in IAB waters and the process of metamorphosis from the pelagic larval phase (pre-settled) to the demersal juvenile phase (post-settled) in different habitats of seagrass meadows were thought to influence the differences in the characteristics morphometrics of *S. canaliculatus* between habitats of seagrass meadows. These findings provide valuable information regarding the importance of considering seagrass habitat in supporting fisheries management for sustainable utilization.

INTRODUCTION

The phenotype is the outward form or the traits that appear due to the interaction between the genotype and the environment **(Wedemeyer, 2001; Mukhopadhyay &Bhattacharjee, 2016)**. These morphometric features (phenotype) typically exhibit ontogenetic changes in the body shape, which are exceptionally rapid during significant life history phases **(Dwivedi & Dubey, 2012)**. Patterns of phenotypic variation in morphological characters can be used as an evidence of genetic divergence **(Swain & Foote, 1999)**. This information can be applied in fisheries management **(Begg & Waldman, 1999; Turan, 1999; Canty *et al.*, 2018)**. Compared with the genotyping and otolith analysis approaches that require a high level of technical expertise and a longer turnaround time, the morphometric analysis approach requires a lower level of technical expertise, with a shorter processing time from data collection to interpretation, and the lowest cost per sample. Therefore, the morphometric analysis approach can be a solid complement to stock identification approaches based on genetic and environmental approaches **(Turan, 1999; Cardin, 2020)**.

The use of the truss morphometric methodcan accurately describe character shapes (patterns) by comparing the size of morphological parts between species and populations **(Strauss & Bookstein, 1982)**. The advantage of using the truss morphometric method, according to **Strauss and Bond (1990)**, is that the truss character set ensures a regular body coverage to detect differences in the body shape by reconstructing from measured distances without the loss of information and eliminating statistical measurement errors by averaging all body shapes.

The white-spotted rabbitfish (*Siganus canaliculatus*) is one of the most economically important herbivorous fish from the order Percifomes, family Siganidae **(Woodland, 2001; Latuconsina *et al.*, 2023a)**. Distribution of *S. canaliculatus* covers the Indo-Pacific waters, including the Indonesian waters, and lives in seagrass meadows, mangroves, and coral reefs **(Allen & Erdmann, 2012; Ambo-Rappeet *et al.*, 2013; Latuconsina & Ambo-Rappe, 2013; Suardi *et al.*, 2016)**. *S. canaliculatus* is widely distributed in the waters of Inner Ambon Bay (IAB) in various types of seagrass habitats **(Ambo-Rappe *et al.*, 2013; Latuconsina *et al.*, 2020a)**. Moreover, it is also widely distributed both during the day and night, as well as in different moon phases, thereby influencing the structure of fish communities in seagrass meadows on IAB waters **(Latuconsina *et al.*, 2012; Latuconsina & Ambo-Rappe, 2013)**. The growth and reproductive biology of *S. canaliculatus* tends to differ between seagrass habitats since it is related to the environmental support **(Latuconsina *et al.*, 2022)**.

The morphological characters of *S. canaliculatus* are often used as a reference for identification, kinship mapping, and taxonomy. Biogeographical differences affect the morphological characteristics of *S. canaliculatus* populations, such as between the Bone Bay and the Makassar Strait, Indonesia **(Sahabuddin *et al.*, 2015)**, and is strongly associated with genetic variation **(Sahabuddin *et al.*, 2019)**. There are also phenotypic differences between male and female *S. canaliculatus***(Suwarni *et al.*, 2020)**. Truss morphometric studies in *Siganus canaliculatus* populations have been reported by **Rasheeq *et al.* (2023)** over a large area along the Indian coast. However, information on phenotypic variations of *S. canaliculatus* in semi-enclosed small bay waters is still not widely available, especially based on the truss morphometric method. Therefore, this research is essential to reveal whether different seagrass habitats in small semi-enclosed bays such as IAB waters will affect the variation in the morphometric characteristics of *S. canaliculatus* populations.

The water of Ambon Bay is a small semi-enclosed type of bay, which is divided into two parts, namely Inner Ambon Bay (IAB), naturally separated from Outer Ambon Bay (OAB) by an inlet (sill) with a depth of ± 12m, causing the circulation of water masses not to run smoothly **(Debby *et al.*, 2009**; **Basit *et al.*, 2012; Saputra & Lekalette, 2016)**. **Putra and Pratomo (2019)** reported a unique current pattern in Ambon Bay, with a current speed that tends to be small at the highest tide (0.01m/s), the direction of the current only rotates in IAB waters. While at the lowest tide, the current speeds range from 0.015– 0.030m/s, with the dominant direction toward OAB waters. According to **Fadli *et al.* (2014)**, movement and current patterns play an essential role in changing the mass of water in Ambon Bay. This phenomenon certainly supports the spatial distribution of *S. canaliculatus* pelagic larvae, thereby influencing population genetic variations between different seagrass habitats **(Latuconsina *et al.*, 2024)**, and has the potential to support differences in morphometric characteristics. This study aimed to compare the morphometric characteristics of the *S. canaliculatus* populations between different seagrass habitats. It is hoped that the results of the investigation of the morphometric characteristics of the *S. canaliculatus* populations between seagrass habitats can validate and strengthen information on genetic variation in IAB waters for the benefit of habitat-based fisheries management in order to support its sustainable utilization.

MATERIALS AND METHODS

1. Fish sampling

Fish samples were collected from the IAB waters based on different seagrass habitats, namely mixed vegetation with seagrass habitat conditions that are not flowed by rivers and a substrate of fine sand to coarse sand and coral fragments, including two observation stations, namely the stations of Tanjung Tiram (3°39'16.5"S and 128°12'0.43 "E) and Halong (3°39'32.9"S and 128°12'31.2"E), and the single vegetation with habitat conditions that are flowed by rivers and have mud substrates, including two observation stations, namely the station of Poka (3°38'36.48"S and 128°11'42.54"E) and Nania (3°37'58.7"S and 128°13'45.1" E) (Fig. 1). Fish samples were taken at the same time in July 2019.

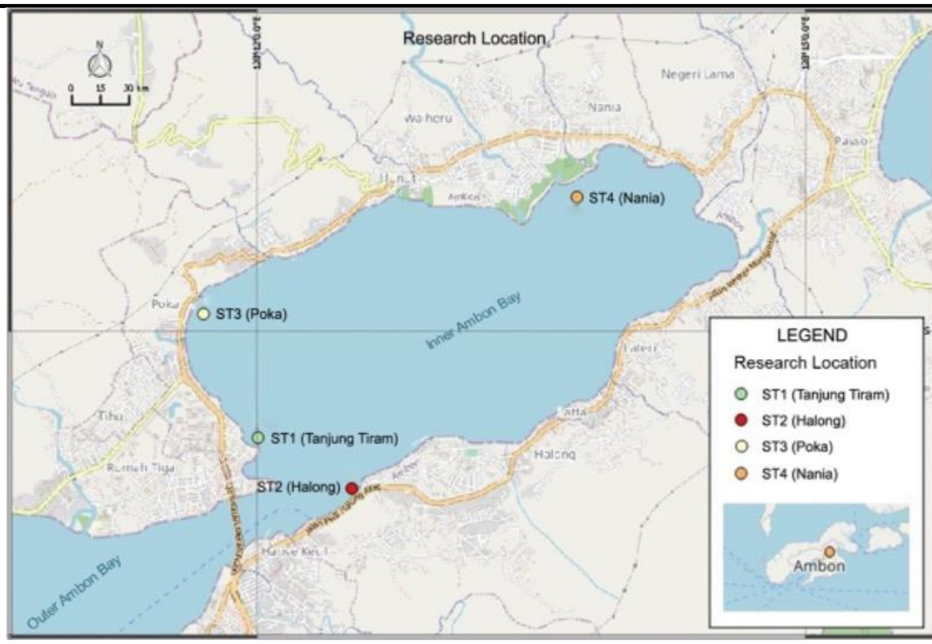

Fig. 1. Map of Inner Ambon Bay (IAB), Maluku, Indonesia, with sampling stations representing different habitats of seagrass meadows

2. Biometric measurements

Fifty fish samples were collected from four stations using beach seines. The use of the truss morphometric method is to divide the fish's body into several truss spaces, by first determining the anchor points on the protruding parts of the body as well as information on the truss characteristics used in the analysis of the morphometric diversity of *S. canaliculatus* (Fig. 2 & Table 1). Biometric measurements of fish samples were carried out at the Oceanographic Biology Laboratory, Deep-Sea Research Center – National Research and Innovation Agency (BRIN), Ambon, Indonesia.

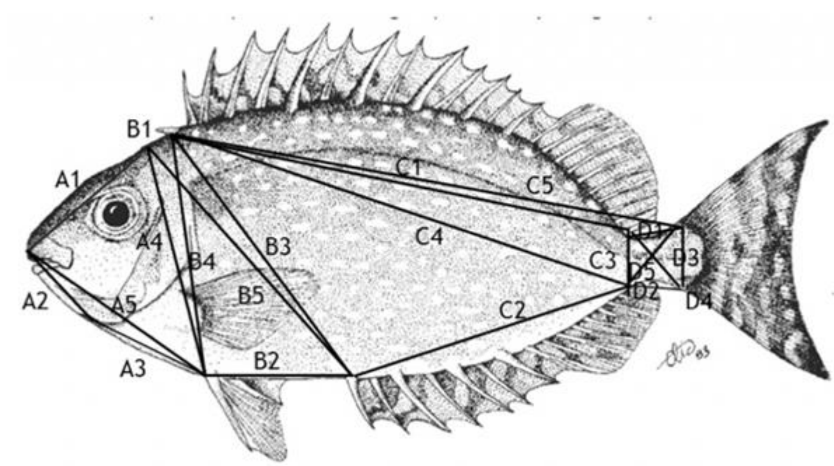

Fig. 2. Truss morphometric method for biometric measurements of *Siganus canaliculatus*

Table 1. Information on the truss morphometric characters of *Siganus canaliculatus*

No.	Trusses field	Code	Description of distance
1.	Head	A1	Upper end of the mouth to the end of the cranial
2.		A2	Upper end of the mouth to the lower end of the operculum
3.		A3	Lower end of the operculum to the beginning of the pelvic fins
4.		A4	End of the cranial to the beginning of the pelvic fins
5.		A5	Upper end of the mouth to the beginning of the pelvic fins
6.	Anterior of the body	B1	End of the cranial to the beginning of the dorsal fin
7.		B2	Beginning of the pelvic fin to the beginning of the anal fin
8.		B3	Beginning of the dorsal fin to the Beginning of the anal fin
9.		B4	Beginning of the pelvic fin to the Beginning of the dorsal fin
10.		B5	End of the cranial to the beginning of the anal fin
11.	Posterior of the body	C1	Beginning of the dorsal fin to the end of the dorsal fin
12.		C2	Beginning of the anal fin to the end of the anal fin
13.		C3	End of the dorsal fin to the end of the anal fin
14.		C4	Beginning of the dorsal fin to the End of the anal fin
15.		C5	Beginning of dorsal fin to the beginning of upper of the caudal fin
16.	Base of caudal	D1	End of the dorsal fin to the beginning of upper of the caudal fin
17.		D2	End of the anal fin to the beginning of lower of the caudal fin
18.		D3	End of upper of the caudal fin to the beginning of lower of the caudal fin
19.		D4	End of the dorsal fin to the beginning of lower of the caudal fin
20.		D5	End of the anal fin to the beginning of upper of the caudal fin

3. Data analysis

Truss morphometrics data were analyzed using Software Minitab ver.16 for PCA and cluster or similarity dendrogram, while the canonical discriminant used SPSS ver. 16. The discriminant analysis was used to analyze differences in biometric characters between groups of the dependent variable. It identifiesvariables that cause differences between groups. The canonical discriminant analysis provides an overview of the distribution of individuals within and between populations representing different of seagrass meadows habitats.

RESULTS

Comparison of interpopulation morphometric characteristics of the white-spotted rabbitfish (*Siganus canaliculatus*) in various seagrass habitats in the waters of Inner Ambon Bay (IAB) using principal component analysis (PCA) shows population grouping based on morphometric similarities, as shown in Fig. (3).

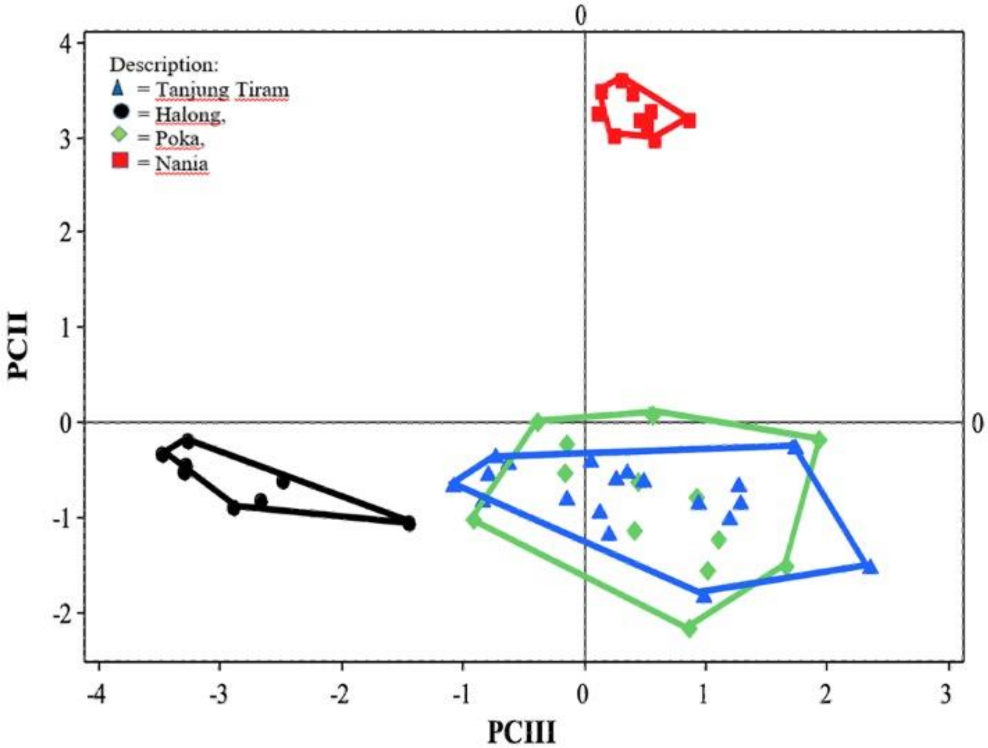

Fig. 3. *Siganus canaliculatus* interpopulation grouping between different seagrass habitats in IAB waters, combination of PCII and PCII

Fig. (3) shows the results of the principal component analysis (PCA) of 50 individual species of *S. canaliculatus* at four observation stations with measurements of 21 characters indicating that the combination of principal component (PCII and PCIII) can describe Halong and Nania populations. Meanwhile, the populations of Tanjung Tiram and Poka still overlap. The condition of each habitat of seagrass meadows with the support of unique environmental factors in IAB waters is thought to influence the morphometrics variation (phenotype) of the associated *S. canaliculatus*.

The results of morphometric character measurements (Table 2) after being analyzed using PCA show that the combination of the principal components (PCII and PCIII) is a combination that can group *S. canaliculatus* into three subpopulations between seagrass habitats in the IAB waters.The differences due to changes in the body shape clearly form 3 separate groupings of *Siganus canaliculatus* populations based on PCA analysis (Fig. 4).

Table 2. PCII and PCIII factor coefficient values of *Siganus canaliculatus* interpopulation in IAB waters

No.	Character code	Principal component	
		PCII	PCIII
1.	**A1**	**0,223**	**0,220**
2.	A2	0,035	0,284
3.	A3	0,022	0,189
4.	A4	0,075	0,086
5.	A5	0,010	0,065
6.	**B1**	**0,577**	**0,137**
7.	B2	0,093	0,217
8.	B3	0,044	0,314
9.	B4	0,028	0,232
10.	B5	0,346	0,010
11.	C1	0,084	0,045
12.	C2	0,147	0,152
13.	C3	0,014	0,304
14.	C4	0,127	0,163
15.	C5	0,142	0,210
16.	D1	0,017	0,287
17.	D2	0,248	0,307
18.	D3	0,459	0,216
19.	D4	0,345	0,039
20.	D5	0,148	0,431

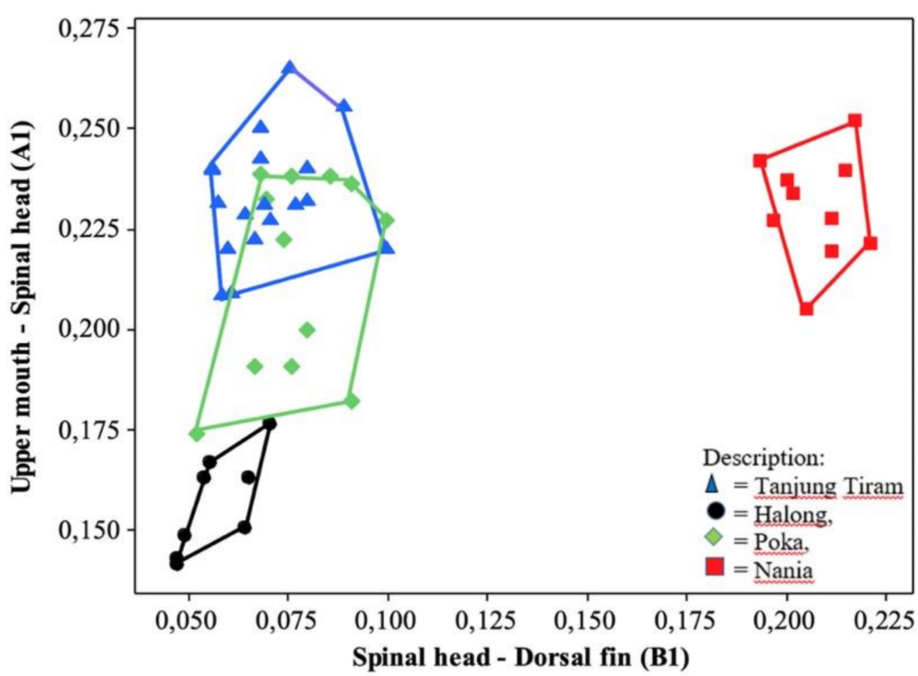

Fig. 4. Combination of characters A1 and B1 on the interpopulation truss morphometric plane *Siganus canaliculatus* in IAB waters

The results of this analysis combine two differentiating biometric characters, namely: The upper end of the mouth to the end of the cranial (A1), and the end of the cranial to the beginning of the dorsal fin (B1). Fig. (4) shows the best combination of biometric characters that separate *S. canaliculus* populations between observation stations in IAB waters, namely characters A1 and B1, which are critical differences between populations that occupy different seagrass habitats. The results of combining the two differentiating morphometric characters produce three separate subpopulations in the scatter plot, where the populations of *S. canaliculatus* at Tanjung Tiram and Poka stations are one subpopulation, while in Halong and Nania each is separated to form a different subpopulation.

The results of the canonical discriminant analysis between *S.canaliculatus* populations show that the center of distribution of the morphometric characters of the *S. canaliculatus* population in IAB waters overlaps between two observation stations, namely: Tanjung Tiram and Poka stations, as shown in Fig.(5). Meanwhile, Halong and Nania stations form a much separate group.

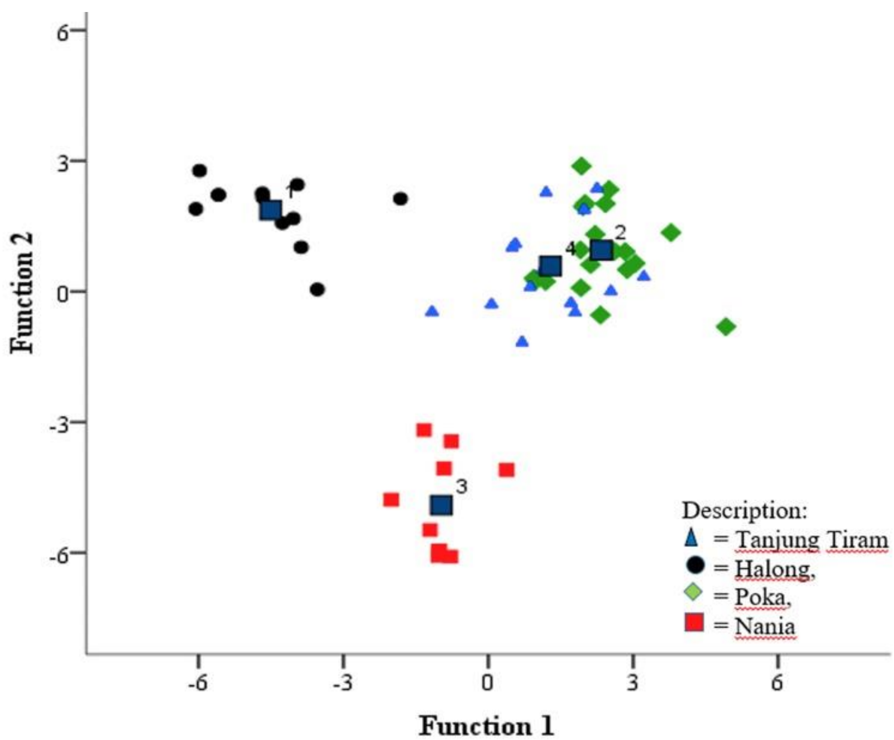

Fig. 5. Sharing component intrapopulation of *Siganus canaliculatus* between different seagrass habitats in IAB waters

The percentage of component sharing to determine intrapopulation and interpopulation similarity of *S. canaliculatus* is shown in Table (3).

Table 3. Percentage sharing component intra and inter population of *Siganus canaliculatus* values in IAB waters based on canonical discriminants analysis

Site sampling	Tg.Tiram(%)	Halong (%)	Poka (%)	Nania (%)	Total (%)
Tg. Tiram	46.7*	6.7	40.0	6.7	100
Halong	0	83.3*	8.3	8.3	100
Poka	26.3	0	73.7*	0	100
Nania	10.0	0	20.0	70.0*	100

* Percentage ofshared component intrapopulation of *S. canaliculatus*

The highest value of intrapopulation sharing components was 83.3% at Halong station (Table 3), indicating no measurable mixing. Meanwhile, the component distribution of scores between stations is low, namely 0% between Nania and Halong, Poka and Nania, and Halong and Tanjung Tiram, which indicates that there is no measured mixing between these populations.

Interpopulation clusters of *S. canaliculatus* differ between seagrass habitats based on the similarity of morphometric characters, as seen in Fig.(6), which shows the highest similarity of morphometric characters in populations at Tanjung Tiram and Poka stations, with99.91%. Between Halong station and Tanjung Tiram and Poka stations, the similarity is 99.49%, and between the population at Nania station and the population at the other three stations (Tanjung Tiram, Poka and Halong), the similarity is 98.66%.

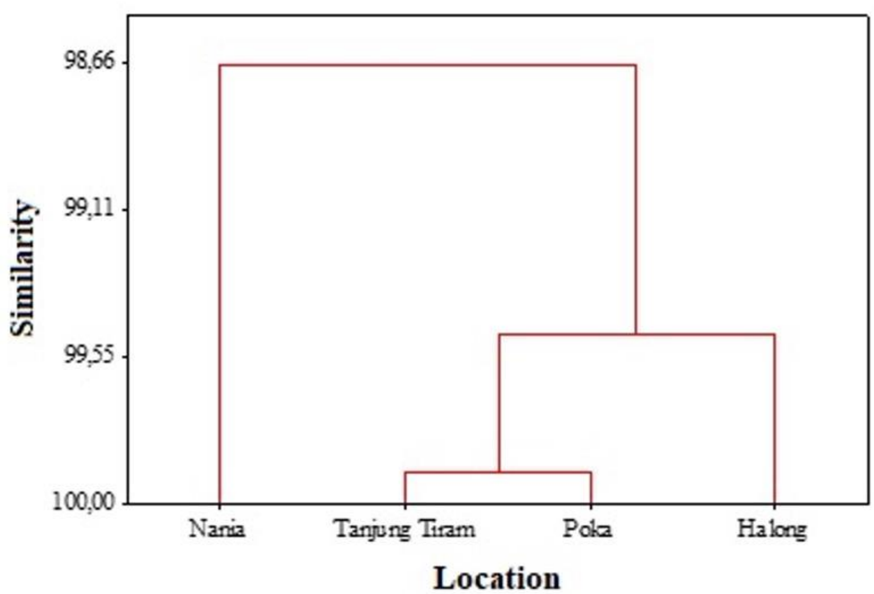

Fig. 6. Dendogram similarity morphometric characters of *Siganus canaliculatus* populations between different seagrass habitat in IAB waters

The high similarity in morphometric characters between the Tanjung Tiran and Poka stations is thought to be due to their close location and the existence of tidal current patterns that connect the two observation stations, thereby supporting connectivity between the two populations as a medium for the spatial distribution pelagic larvae of *S. canaliculatus*. Meanwhile, Nania station is the furthest location from the other three stations; therefore, it has a smaller morphometric character similarity value when compared to the other three stations.

DISCUSSION

Poka and Nania stations have monospecific seagrass habitats that are flowed by rivers so they have similar properties in terms of typical turbidity values, dissolved oxygen, chlorophyll-a, and high temperatures. Meanwhile, Tanjung Tiram station, which has the same high phosphate and nitrate levels as Halong station, has high salinity and pH characteristics since the absence of river influence can cause pH and salinity fluctuations **(Latuconsina *et al.*, 2020a)**. These different habitat characteristics determine the morphometric variation of the *Siganus canaliculatus* population. According to **Tave (1993)**, environmental conditions, genetic factors, and genetic and environmental interactions can influence the phenotypic differences. The phenotype results from the interaction between the genotype and the environment and is an external manifestation or visible trait **(Wedemeyer, 2001; Mukhopadhyay & Bhattacharjee, 2016)**.

Principal components (PC) can provide geometric interpretations, and component scores are configuration measures that can represent changes in the fish body shape **(Strauss & Bookstein, 1982)**. This means that the high main component scores in character codes A1 and B1 indicate differences due to changes in the body shape between fish populations in different seagrass habitats in the IAB waters. This difference in morphometric variation is thought to be related to environmental variation and may reflect genetic variation. According to **Li *et al.* (1993)** and **Tave (1993)**, phenotypic differences are influenced by genetics, environment, and genetic interactions with the environment. **Swain and Foote (1999)** explained that patterns of phenotypic variation in morphological characters can sometimes be an evidence of genetic divergence. Thus, using phenotypic characters becomes very important. According to **Mir *et al*. (2013)**, phenotypic character differences are more caused by environmental influences than genetic differentiation.

Three population groups (subpopulations) of *S. canaliculatus* based on morphometric similarity recorded the highest similarity at Tanjung Tiram and Poka stations. This is possible because *S. canaliculatus* at the two stations is still in the same population since they are close together. Apart from that, there is no interconnection between Tanjung Tiram, Poka, and Halong stations and Nania stations. This is thought to be related to the geographical distance between Nania station and the other third station, which are pretty far apart. Tidal currents, as one of the dominant oceanographic parameters, are also thought to support the formation of three subpopulations of *S. canaliculatus* in the IAB waters. **Saputra and Lekalette (2016)** and **Putra and Pratomo (2019)** elucidated that the tidal currents in the IAB waters have different patterns and are dominated by upwelling (East Monsoon) and downwelling (West Monsoon) phenomena. Hence, it is assumed that the spatial distribution of the pelagic larvae of *S. canaliculatus* follows the pattern and direction of the tidal currents. This results in the pelagic larvae of *S. canaliculatus* being placed in seagrass habitats that align with the direction of the current. According to **Fisher *et al*. (2005)**, the rabbitfish (*Siganus* spp.) exhibits the potential for wide spatial distribution with the support of ocean currents due to the ability of the pelagic larvae to swim at speeds of 34.2– 87.1cm/s.

Saputra and Lekalette (2016) reported that the pattern of current direction during the high tide at a depth of 15m indicates that the current at IAB tends to rotate in a circle in a counter clockwise direction. This indicates that the water masses inside the IAB tend to be unable to exit the OAB. While, the current pattern originating from the OAB generally moves northeast toward the IAB. The current's movement at a depth of 15m is essential in the change of water masses in Ambon Bay, and it is suggested to play an essential role in the distribution of the *S. canaliculatus* pelagic larvae in different seagrass habitats in the IAB waters. **Putra and Pratomo (2019)** found that the currents during full moon tides show speeds between 0.010 to 0.273m/ s at a depth of 5m and between 0.015 and 0.425m/ s at a depth of 15m. According to **Saputra and Lekalette (2016)**, the highest speed tends to be small at high tide, namely 0.01m/s, and the direction of the current only rotates in the IAB waters, while at the lowest ebb, the range of the current speeds is 0.015– 0.030m/s, with the direction dominant toward the OAB waters.

For the populations at Halong and Nania stations, each form their groups. Several individuals of *S. canaliculatus* from the Tanjung Tiram population were seen approaching the center of distribution of the morphometric characters of *S. canaliculatus* at Halong station and vice versa, allegedly due to the geographical distance between the two stations, which are relatively close together but separated by the IAB inlet (sill) which connects to the OAB. Therefore, the low tidal currents are the main obstacle for the spatial distribution of the pelagic larvae of *S. canaliculatus* between the two stations. After being carried away by ocean currents, the pelagic larvae of *S. canaliculatus* will metamorphose into demersal juveniles in each seagrass habitat they occupy and grow and develop by adapting to the environmental conditions of each seagrass habitat. According to **Bobiles *et al.* (2015)**, *S. canaliculatus* changed its body morphology when it began to settle in seagrass beds after experiencing a transition from the pelagic larvae phase to the demersal juvenile phase, with the support of better food availability and environmental factors that ensured more growth and development. According to **Wellington and Victor (1992)**, faster-growing fish spend less time in the planktonic larvae phase, and if the environment is unfavorable, they may delay the metamorphosis from the planktonic larval phase to the demersal juvenile phase. Water temperature is one of the most significant factors affecting the development rate of fish metamorphosis **(McCormick & Molony, 1995)**. Such a phenomenon is thought to make differences in the morphometric characteristics of the *S. canaliculatus* populations between seagrass habitats in the IAB waters.

The differences in morphometric characteristics of the *S. canaliculatus* populations between seagrass habitats may be related to the metamorphosis process of *S. canaliculatus* from the pelagic larval phase to the demersal juvenile phase, which will be related to its sensory system, where this change occurs in each seagrass habitat which is different in terms of its supporting environmental characteristics in the IAB waters. According to **Bobiles *et al.* (2015)**, the transition from the pelagic larvae to demersal juveniles causes physiological changes in *S. canaliculatus*, where changes are seen in the otolith structure between the pre-settled and post-settled stages, which can be associated with a decrease in the dependence on the larval stage (pre-settled) and an increase in the visual dependence of *S. canaliculatus* in the juvenile phase (post-settled) for the habitat of seagrass meadows. **Swain and Foote (1999)** stated that the morphometric differences may indicate that groups of fish have different environments or habitats at critical developmental stages. Furthermore, if shape-changing onto genetic events involves reproductive development (e.g., onset of sexual maturity, seasonal spawning patterns), they will determine morphometric differences between populations.

Differences in the morphometric characteristics of the *S. canaliculatus* population groups between seagrass habitats in the IAB waters indicate that the complexity of seagrass habitat structure, supported by various environmental parameters, can have relatively different influences on the size structure, growth, and reproductive biology of *S. canaliculatus* **(Latuconsina *et al.*, 2020a; Latuconsina *et al.*, 2022)**. According to **Ambo-Rappe *et al.* (2013)**, the specific role of the seagrass beds for fish can be determined by their structural complexity (seagrass species composition), seagrass surface area, and environmental, physical parameters such as waves and currents where these various parameters will have different effects on various stages of fish life. The current condition of the *S. canaliculatus* population in the IAB waters, coupled with the threat of destruction of the seagrass habitat due to organic waste disposal, high sedimentation, and heavy metal pollution in the area **(Debby *et al.*, 2009; Pello *et al.*, 2014; Irawan & Nganro, 2016; Noya *et al.*, 2017)**, in the form of increasing mortality and exploitation rates of *S. canaliculatus* **(Latuconsina *et al.*, 2020b)**, has the potential to change the environment and increase the opportunities for the emergence of various diseases. This ultimately has the potential to reduce populations and genetic diversity, so that in the long term, it can threaten the sustainability of the *S. canaliculatus* stocks in the IAB waters. Hence, a seagrass habitat-based management strategy is needed for its sustainable utilization.

The formation of three subpopulations of *S. canaliculatus* based on the similarity of morphometric characters in the IAB waters follows the grouping of the three subpopulations based on the similarity of genetic characters, as reported by **Latuconsina *et al.* (2024)**. This phenomenon proves that genetic variation can be expressed through phenotypic characteristics **(Li et *al.*, 1993; Tave, 1993)**. **Bachry *et al.*(2019)** revealed that environmental interactions are constructive in the diversity of phenotypic characters of aquatic biota. Thus, the high diversity of morphological characters (phenotypes) of a population is most likely caused by the interactions between environmental and genetic factors. According to **Dwivedi and Dubey (2012)**, the quantitative morphometric characteristics are generally related to the fitness of the fish and their response to natural selection through local adaptation, rapid adaptive divergence between newly separated groups, and genetic differences maintained through selection in the face of the gene flow, as reflected in morphometric characteristics.

The findings in this study confirm that the morphometric characteristics approach may be more applicable to studying short-term differences caused by environmental influences and effective for fisheries management, in accordance with the statements of **Mojekwu and Anumudu (2015)** and **Tripathy (2020)**. The morphometric approach can be employed to assess the growth and development of fish populations. It systematically identifies variations and structures in population characteristics, aiding in stock identification by distinguishing populations based on differences in growth rates and reproductive dynamics. This method is effective for stock management and conservation programs. Furthermore, its validity is enhanced when combined with genetic approaches **(Turan, 1999; Rawat *et al.*, 2017; Tripathy, 2020)**.

CONCLUSION

There are three population groups (sub-populations) of *Siganus canaliculatus* in Inner Ambon Bay based on differences in morphometrics characteristics. The two key distinguishing characteristics between the three population groups are: the upper end of the mouth to the end of the cranial (A1), and the end of the cranial to the beginning of the dorsal fin (B1). Differences in morphometric characters between *S. canaliculatus* population groups representing different seagrass habitats in the IAB waters, are thought to be influenced by two factors, namely: 1) tidal current patterns which act as a link or barrier to the spatial distribution of the pelagic larvae between different seagrass habitats, and 2) relatively different environmental factors in each seagrass habitat which have the potential to influence genotypic characters and can be expressed in the phenotypic characters of the *S. canaliculatus* population through development from the pelagic larval stage (pre-settled) to the juvenile demersal phase (post-settled). This finding is a valuable source of information about the ecological benefits of various types of seagrass habitat in supporting the growth and development of *S. canaliculatus*, which can be considered in fisheries management strategies, including seagrass habitat-based conservation areas in the IAB waters.

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