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MORPHOMETRIC AND MERISTIC CHARACTERISTICS OF STREAMLINED SPINEFOOT *Siganus argenteus* (Quoy & Gaimard, 1825) IN SPERMONDE ARCHIPELAGO, SOUTH SULAWESI

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ABSTRACT

Siganus argenteus (Quoy & Gaimard, 1825) is a herbivorous reef fish that plays an important ecological role and has high economic value in coastal areas. Previous studies have examined the morphometric and meristic characteristics of various Siganidae species, but information on the characteristics of *S. argenteus* based on samples landed at the Paotere Fish Auction Site (TPI) in Makassar remains limited. This study aims to analyze the morphometric and meristic characteristics of *S. argenteus* in the Spermonde Archipelago, South Sulawesi. A total of 50 individuals were collected at the Paotere Fish Auction Market (TPI) in Makassar during January-February 2026. The analysis was conducted through morphometric measurements, counting of meristic characters, and Principal Component Analysis (PCA). The results showed that total length ranged from 174.7 to 214.2 mm with an average of 192 mm, while standard length ranged from 144.4 to 192.7 mm with an average of 159.4 mm. Meristic characters included XIII spines and 10 rays in the dorsal fin, (VII) spines and 9 rays in the anal fin, and II spines and 3 rays in the pelvic fin. Variation was observed in the rays of the pectoral fins (15-18) and the caudal fin (17-21). PCA analysis showed that the first principal component explained 99.03% of the morphometric variation, with prodorsal length (Pdl) as the character with the greatest contribution, while the second principal component explained 0.42%. These results indicate that morphometric variation in the sample is primarily related to body size.

Keywords: *Siganus argenteus*, morphology, meristic, characteristics, Spermonde Archipelago.

INTRODUCTION

Siganus argenteus (Quoy & Gaimard, 1825) is a member of the family Siganidae that has been described from the Indo-Pacific region and is known to have a wide distribution in tropical waters ranging from East Africa to the Pacific Islands, primarily in coral reef and shallow lagoon habitats (Taylor et al., 2016). In Indonesia, this species is known locally as *baronang bulo*, while in international literature it is known by the common name Forktail rabbitfish (Al-Sal et al., 2021).

Morphologically, *S. argenteus* is characterized by a relatively slender fusiform body shape with an elongated body profile and a forked caudal fin, as well as a head morphology featuring a blunt snout and a small mouth that tends to be in a terminal to slightly inferior position, which is a key character in the identification of this species (Salaki et al., 2016). In addition, this species exhibits life-history characteristics such as relatively rapid growth, a short lifespan, and reproduction via pelagic eggs, which allow for the widespread dispersal of larvae in open waters (Taylor et al., 2016)

Ecologically, *S. argenteus* typically inhabits shallow waters with a strong association with seagrass and coral reef ecosystems, which serve as food sources, nursery areas, and protection from predators. Aquatic environmental conditions, such as habitat quality, temperature, and oceanographic dynamics, are known to influence growth patterns and population size structure (Turang et al., 2019). Additionally, biological aspects such as reproduction and size distribution are closely linked to coastal environmental dynamics that determine population sustainability (Widiana et al., 2023). Variations in these environmental conditions can trigger changes in phenotypic traits, reflected through morphometric and meristic variations (Nurilmala et al., 2022). Morphological characters in the genus *Siganus* have also been reported to reflect phylogenetic relationships and responses to different environmental conditions (Burhanuddin et al., 2025).

Morphometric and meristic analyses have proven effective in identifying population structure and phenotypic differentiation in fish through variations in morphological traits among populations that reflect stock separation (Zakiya et al., 2023). These character variations are influenced by environmental conditions, where differences in habitat and ecological factors result in significant changes in fish morphometric characters (Azrita et al., 2024). Environmental changes resulting from anthropogenic activities in coastal areas are known to trigger changes in the morphological traits and population structure of aquatic organisms (Sahabuddin et al., 2015). The Spermonde

Archipelago, as an area under high environmental pressure, exhibit habitat degradation that has the potential to affect the biological traits of the marine organisms living there (Hermawati et al., 2024).

Previous studies have reported morphometric and meristic variations in the family Siganidae, including differences associated with habitat substrate in the Spermonde Archipelago (Yunus et al., 2025), meristic variation within the genus *Siganus* in Sulawesi waters (Burhanuddin et al., 2014), and high morphometric similarity among *Siganus canaliculatus* populations in Bone Bay and the Makassar Strait. However, information on the morphometric and meristic characteristics of *Siganus argenteus* in the Spermonde Archipelago remains limited.

Therefore, this study aims to analyze the morphometric and meristic characteristics of *Siganus argenteus* in the Spermonde Archipelago through a morphometric-meristic approach and meristic characters in a number of sample individuals. The results of this study are expected to provide more comprehensive scientific information regarding population structure, morphological adaptation patterns, and contributions to sustainable fisheries resource management in coastal areas.

MATERIALS AND METHODS

Time and Location of Research

The sample used in this study consisted of 50 *S. argenteus* fish collected from January to February 2026 at the Paotere Landing Fish, Gusung Village, Makassar, South Sulawesi:

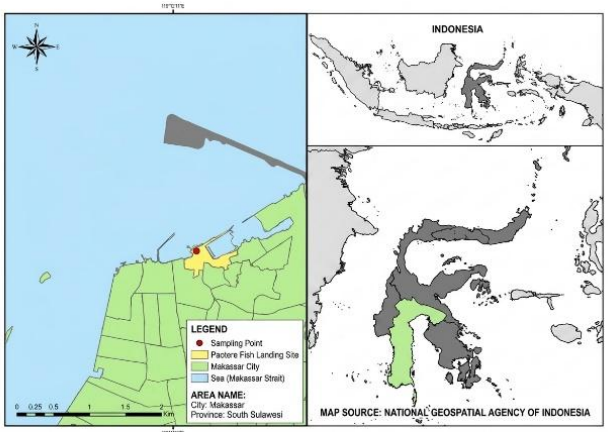


Figure 1. Map of the sampling locations for *Siganus argenteus* at the Paotere Fish Landing Site, Makassar.



Figure 2. Conditions at the sampling site for *Siganus argenteus* at the Paotere Fish Landing Site

Morphometric and meristic analysis

This study was conducted at the Marine Biology Laboratory, Faculty of Marine Sciences and Fisheries, Hasanuddin University, Makassar, South Sulawesi. Samples were identified using a morphological approach, focusing on morphometric and meristic characteristics. Fish samples were collected from the Paotere Landing Fish, Makassar. The collected samples were then rinsed to remove any attached debris, followed by fin spreading using a 7% formalin solution to facilitate observation, counting, and measurement. Subsequently, the samples were tagged and documented through photography. The samples were then preserved by soaking in a formalin solution for 3 days, followed by soaking in running water for 3 days to remove residual formalin. In the next stage, the samples were soaked in an alcohol solution for 7 days as a further preservation process. After all preparation stages were completed, morphometric measurements and observations of meristic characters were conducted on the samples. Morphometric measurements were carried out meticulously following the protocol of Randall & Kulbicki. (2005). Morphometric measurements were taken using a Vernier caliper with a precision of 0.01 mm.

The main parameters measured included body dimensions (Figure 3). In addition, meristic characters were calculated, including Dorsal Fin Spine (DFS), Dorsal Fin Rays (DFR), Anal Fin Spine (AFS), Anal Fin Rays (AFR), Ventral Fin Spine (VFS), Ventral Fin Rays (VFR), Pectoral Fin Rays (PFR), and Caudal Fin Rays (CFR).

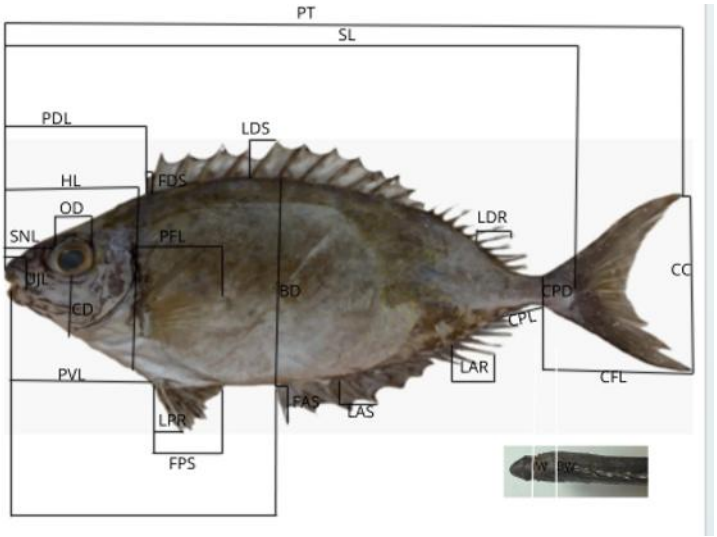


Figure 3. Morphological measurements of *Siganus argenteus* (TL) Total Length, (SL) Standard Length, (BD) Body Depth, (BW) Body Width, (HL) Head Length, (SNL) Snout Length, (OD) Orbital Diameter, (IW) Interorbital Width, (CD) Cheek depth, (UJL) Upper-jaw length, (CPD) Caudal-peduncle depth, (CPL) Caudal-peduncle length, (PDL) Predorsal length, (PAL) Preanal length, (PVL) Prepelvic length, (FDS) First dorsal spine, (LDS) Longest dorsal spine, (LDR) Longest dorsal ray, (FAS) First anal spine, (LAS) Longest anal spine, (LAR) Longest anal ray, (CFL) Caudal-fin length, (CC) Caudal concavity, (PFL) Pectoral-fin length, (FPS) First pelvic spine, (LPR) Longest pelvic ray.

RESULTS AND DISCUSSION

Description: The observed specimens of *Siganus argenteus* exhibited varying sizes and shapes (Table 1) (Figure 3). The body is elongated oval and laterally compressed (compressed body) with an average length of 192 mm. The body proportions appear relatively tall compared to its length, with symmetrical dorsal and ventral sections forming an elliptical silhouette. The head features eyes that are large (6.7% SL) and prominent (large orbit). The mouth is small, averaging 9.6% SL, and the gill cover (operculum) is clearly visible with a smooth texture. The elongated, oval, and laterally compressed body shape of *Siganus argenteus* is a common morphological characteristic of the Siganidae family, which inhabits coastal and coral reef ecosystems (Mahrus & Syukur, 2020). This morphological characteristic is consistent with the pattern of body shape differentiation in Siganidae influenced by environmental selection, particularly regarding mobility and habitat space utilization, where variations in body proportions serve as key indicators of ecological adaptation and evolutionary form in reef fish (Zolkaply et al., 2021). Behaviorally, Siganidae are known to exhibit a tendency toward pair formation in the adult phase as a reproductive strategy related to spawning efficiency and reduced predation risk, indicating a more organized social structure compared to other coral reef herbivorous fish (Brandl, 2016). Additionally, *S. argenteus* plays a vital ecological role as a herbivore that controls macroalgal communities, where grazing activity contributes to the stability of benthic community structure and prevents algal dominance in coral reef ecosystems (Latuconsina et al., 2024). The integration of reproductive behavior and ecological function demonstrates that *Siganus argenteus* plays a vital role as a herbivorous fish in maintaining the balance of tropical coral reef ecosystems and adapting to complex coastal habitats (Taylor et al., 2016; Eggertsen et al., 2019).

Table 1. Morphometric measurement results for *Siganus argenteus*.

Character	***Siganus argenteus*** **N=50** **Mean±SE (Range)**
Morphometric	
Total length	192±9.9 (174.7–214.2)
Standard Length	159.4±9.7 (144.4-192.7)
%SL	
Body depth	36.1±1.2 (34.0–38.3)

Character	*Siganus argenteus* N=50 Mean±SE (Range)
Body width	11.6±0.9(7.0–12.8)
Head length	23.9±0.9 (22.1–25.8)
Snout length	9.6±0.7 (7.5–10.6)
Orbital diameter	6.7±0.6 (5.4–9.1)
Interorbital width	7.5 ± 0.5 (6.7–8.8)
Cheek depth	10.4 ± 0.7 (8.6–12.6)
Upper-jaw length	5.9 ± 0.4 (4.3–6.5)
Caudal peduncle depth	5.1±0.3 (4.1–5.8)
Caudal peduncle length	5.3 ± 0.6 (4.1–6.4)
Predorsal length	26.2 ± 1.5 (22.3–28.5)
Preanal length	47.5 ± 3.6 (24.3–50.9)
Prepelvic length	27.3 ± 1.2 (24.9–30.3)
First dorsal spine	6.4 ± 0.8 (4.1–7.7)
Longest dorsal spine	10.2 ± 0.7 (8.2–11.3)
Longest dorsal ray	9.3 ± 0.6 (8.0–10.6)
First anal spine	7.8 ± 0.8 (6.1–10.6)
Longest anal spine	10.7±0.8 (8.5–12.4)
Longest anal ray	7.6 ± 0.6 (6.3–8.8)
Caudal fin length	25.4 ± 1.8 (21.9–29.6)
Caudal concavity	1.8 ± 1.2 (0.6–5.5)
Pectoral fin length	15.6 ± 0.7 (14.0–17.9)
First pelvic spine	12.0 ± 1.7 (1.4–13.9)
Longest pelvic ray	12.4 ± 1.3 (6.7–14.3)

For the meristic characters of *Siganus argenteus* compared with two other species, namely *Siganus canaliculatus* and *Siganus sutor* (Valenciennes, 1835) (Table 2), there are several distinguishing characteristics. The meristic data obtained for the species *S. argenteus* in this study show the following fin element counts: 13 (XIII) Dorsal Fin Spines (DFS), 10 Dorsal Fin Rays (DFR), 7(VII) Anal Fin Spines (AFS), 9 Anal Fin Rays (AFR), (2) II Ventral Fin Spines (VFS), Ventral Fin Rays (VFR) 3, Pectoral Fin Rays (PFR) ranging from 15-18 (average 17), and Caudal Fin Rays (CFR) ranging from 17-21 (average 20).

Regarding the context of meristic variation patterns in adjacent regions, a study by Sahabuddin et al. (2015) on *Siganus canaliculatus* in Bone Bay and the Makassar Strait reported that meristic characters (spines and rays) tend to be stable for identification purposes, although variation can still occur in some fin elements. These findings are consistent with the results of a study on *S. argenteus*, particularly regarding the consistency of spines and rays in the dorsal-anal fin, whereas variation is more pronounced in the pectoral fin ray count (PFR) and caudal fin ray count (CFR). Differences in the degree of variation between species and among morphometric-meristic characters are likely related to differences in habitat use strategies and tolerance of hydrodynamic conditions in the Spermonde coastal region.

The meristic characters of *Siganus argenteus* in this study show a pattern that is relatively consistent with other species in the family Siganidae, particularly regarding the number of spines and rays in the dorsal and anal fins, which play a crucial role in the taxonomic identification of *baronang* fish (Mahrus & Syukur, 2020) state that meristic characters in *baronang* fish tend to be stable and effective for species identification. The similarity in morphological and meristic characters among species within the genus *Siganus* also indicates close phylogenetic relationships within the group of coral-feeding herbivorous fish (Suwarni et al., 2020). The DFS, DFR, AFS, and AFR values in this study are similar to those of *S. canaliculatus* and *S. sutor* reported by (Anam et al., 2020), but the VFS and VFR characters were successfully identified with values of 2 and 3, respectively. These differences indicate that certain meristic characters can serve as species-distinguishing features despite sharing similar general morphological patterns. This aligns with (Damora et al., 2025; Ebrahim et al., 2020) who state that morphometric and meristic characters play a crucial role in distinguishing fish species based on their biological and phenotypic variations. Furthermore, the body color patterns observed correspond to the descriptions in (Burhanuddin et al., 2014), thereby reinforcing the validity of species identification based on morphological and meristic characters.

Additionally, differences were observed in the number of Pectoral Fin Rays (PFR). In this study, *Siganus argenteus* had a range of 15-18 (average 17), while *S. canaliculatus* and *S. sutor* were reported to have 17-18. This indicates that *S. argenteus* exhibits a slightly wider range and tends to have a lower minimum value. Regarding Caudal Fin Rays (CFR). A more significant difference is observed in the number of Caudal Fin Rays (CFR). *S. argenteus* showed a range of 17-21 (average 20), whereas the two reference species had relatively constant values, around 18. The higher variation in this character is likely related to environmental factors, such as water hydrodynamic conditions, as well as potential differences in movement patterns and ecological adaptations among the species.

Table 2. Comparison of meristic data for *Siganus argenteus* and several other species

Species	DFS	DFR	AFS	AFR	VFS	VFR	PFR	CFR	Source
Siganus argenteus	XIII	10	VII	9	II	3	15–18 (17)	17-21 (20)	This study
Siganus canaliculatus	XIII	10	VII	9	-	-	17(17-18)	18	Anam et al., 2020
Siganus sutor	XIII	10	VII	9	-	-	17(17-18)	18	Anam et al., 2020

Coloration

The body color of the *Siganus argenteus* species is predominantly grayish-brown with a yellowish gradient between the relatively darker dorsal region and the paler, silvery-toned ventral region, accompanied by a subtle pattern of spots without any prominent lines.

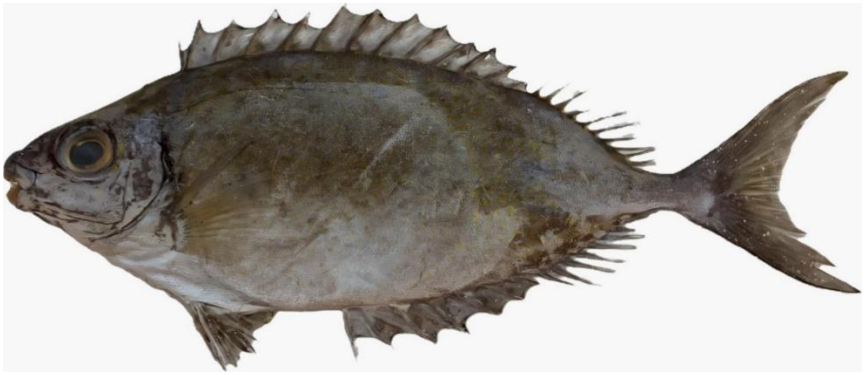


Figure 4. *Siganus argenteus* collected from the Spermonde Archipelago (male), 174.7.

Principal Component Analysis (PCA) (Figure 5) shows that most morphometric variables cluster around the center of the axes, indicating relatively uniform contributions and positive correlations among characters. This pattern confirms that the observed morphometric variations tend to be proportional and better represent size factors rather than shape, thus showing no clear group separation in the PC1-PC2 plane.

The results of the PCA analysis indicate that most *S. argenteus* individuals exhibit a clustered distribution pattern, reflecting a low level of morphological differentiation and high body shape homogeneity Arbajayanti (2022) states that the uniformity of morphometric characters may be influenced by the relatively similar physiological conditions of the individuals. The Pdl character is one of the dominant parameters contributing to morphological variation, as reported by (Putri et al., 2023). This finding is supported by (Mustikawati et al., 2025; Herlinah et al.,2020) who demonstrated that the Pdl character can be a primary contributor in distinguishing phenotypic variations within the genus *Siganus*, even when studied across different species and locations (Herlinah et al., 2020) stated that only certain morphometric characters play a significant role in distinguishing phenotypic variations in fish. The high morphometric homogeneity in this study is suspected to be related to relatively stable environmental conditions, resulting in proportional and uniform body growth patterns. These conditions align with (Sihombing. et al., 2025; Zahid et al., 2022) who state that the stability of the aquatic environment influences the formation of morphometric characteristics in fish populations.

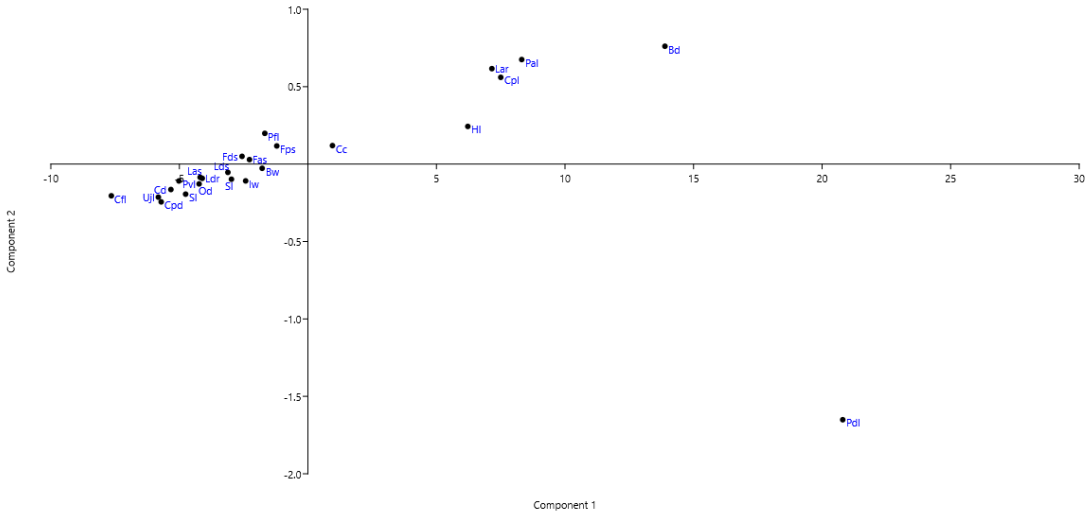


Figure 5. Graph of the loading plot for the Principal Component Analysis (PCA) of the morphometric characteristics of *Siganus argenteus*Total Length (TL), Standard Length (SL), (BD) Body Depth (BD), Body Width (BW), Head Length (HL), Snout Length (SNL), Orbital Diameter (OD), Interorbital Width (IW), Cheek depth (CD), Upper-jaw length (UJL), Caudal-peduncle depth (CPD), Caudal-peduncle length (CPL), Predorsal length (PDL), Preanal length (PAL), Prepelvic length (PVL), First dorsal spine (FDS), Longest dorsal spine (LDS), Longest dorsal ray (LDR), First anal spine (FAS), Longest anal spine (LAS), Longest anal ray (LAR), Caudal-fin length (CFL), Caudal concavity (CC), Pectoral-fin length (PFL), First pelvic spine (FPS), Longest pelvic ray (LPR).

Conversely, some characters show clear deviations from the center of distribution, particularly Pre-dorsal Length (Pdl), which is located at an extreme position relative to the main axis. This indicates that Pdl has a dominant contribution to the formation of Principal Component 1 and acts as the variable with the highest discriminatory power. Additionally, other characters such as Body Depth (Bd), Caudal Peduncle Length (Cpl), Lar, and Head Length (Hl) also showed relatively greater contributions compared to other variables, although not as strong as Pdl. This pattern suggests that while morphometric characters are generally homogeneous, certain variables are more sensitive in capturing variation.

Table 3. Dominant morphometric characters in the Principal Components (PC) of *Siganus argenteus* from the Spermonde region.

Morphometric Character	PC 1 (99.03%)	PC 2 (0.42%)	PC 3 (0.12%)
Pre-dorsal Length (Pdl)	23.05	-1.58	0.45
Pre-anal Length (Pal)	9.45	0.95	-0.12
Lower Jaw Length (Lar)	8.2	0.9	0.15
Head Length (Hl)	7.15	0.4	-0.05
Standard Length (Sl)	-4.2	-0.15	0.08
Eigenvalue	49.51	0.21	0.06
Cumulative Variance (%)	99.03	99.45	99.57

The results of the Principal Component Analysis (PCA) on the *Siganus argenteus* population in the Spermonde Archipelago indicate that morphometric variation is dominated by Principal Component 1 (PC 1), accounting for 99.03% with a total eigenvalue of 49.51. This very high dominance indicates that the diversity among individual samples tends to be influenced by size-dependent variation rather than shape variation. The relative contributions of each character show that Pre-dorsal Length (Pdl) has the highest loading value on PC1, and thus can be considered the morphometric character that plays the most significant role in explaining size variation in the observed population.

The very high dominance of Principal Component 1 (PC1) indicates that morphometric variation in the *Siganus argenteus* population is primarily influenced by body size, as evidenced by the uniformity of proportions among individuals. This suggests a relatively morphometrically homogeneous growth pattern, although it does not directly prove an isometric growth pattern without further allometric analysis. The low variance in Principal Component 2 (PC2) of 0.42%, which generally represents shape variation (shape factor), further confirms that morphological differences between individuals are relatively small and do not indicate significant morphological differentiation.

This study has several limitations. First, the fish samples used were obtained exclusively from catches at the Paotere Fish Landing Site during the January-February 2026 observation period; thus, seasonal variations may not be fully represented. Second, the sample size (n=50) may limit the generalizability of the morphometric-meristic variation patterns to the entire population in the Spermonde Archipelago. Third, the PCA of quantitative morphometric characters primarily revealed size variation due to strong correlations among linear dimensions; consequently, the separation of size and shape effects has not been comprehensively analyzed through allometric analysis normalization procedures or size-independent shape measures. Fourth, although variations in CFR and PFR were discussed as potential environmental responses, direct measurements of environmental parameters (e.g., air quality, currents, habitat availability) at the same locations were not conducted in this study; therefore, causal relationships cannot yet be confirmed.

CONCLUSION

The morphometric and meristic characteristics of *Siganus argenteus* in the Spermonde Archipelago exhibit a relatively homogeneous pattern. Morphometric variation is more influenced by body size than by body shape, as indicated by the results of Principal Component Analysis (PCA), with Principal Component 1 accounting for 99.03% of the total morphometric variation. The Pre-dorsal Length (Pdl) character is the morphometric parameter that contributes most significantly to population diversity. Meanwhile, meristic characters show a relatively stable pattern across all samples, particularly regarding the number of spines and the rays of the dorsal, anal, and ventral fins, thereby reinforcing the taxonomic consistency of the species. Variation in the number of pectoral and caudal fin rays is thought to be related to adaptive responses to aquatic environmental conditions. Overall, the *S. argenteus* population in the Spermonde Archipelago exhibits a high degree of morphological homogeneity with proportional body growth patterns.

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