

Morphological and Morphometric Characteristics of Commercially Traded *Siganus* spp. (Rabbitfish) in Tarakan's Beringin Market

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ABSTRACT

This study aimed to investigate the morphological and morphometric characteristics of commercially traded *Siganus* spp. (Rabbitfish) in Tarakan's Beringin Market. A total of 30 fish specimens were collected from the market and analyzed using 23 morphometric measurements to identify differences in species and provide insights into their population structure. The measurements included total length, standard length, head length, head height, body height, caudal peduncle height, eye diameter, inter-eye distance, body width, and several other parameters related to fins and jaw length. The results showed a wide range of values for each morphometric parameter, suggesting a high degree of morphological variation among the sampled Rabbitfish. For instance, the minimum and maximum total lengths were 15.07 cm and 22.17 cm, respectively, with an average of 10.84 cm and a standard deviation of 1.93. The head length ranged from 2.83 cm to 4.66 cm, with an average of 2.31 cm and a standard deviation of 0.46. Furthermore, the body height varied between 6.52 cm and 8.57 cm, with an average of 4.31 cm and a standard deviation of 0.53. These results, along with the other morphometric parameters, highlight the diverse morphological traits of *Siganus* spp. present in the Beringin Market. Comparisons with previous studies on *Siganus* spp. indicate that the morphological diversity observed in the present study is consistent with the known intraspecific variation within this genus. However, further research is required to determine if the observed differences are due to phenotypic plasticity, genetic differences, or a combination of both factors. This research contributes to a better understanding of the morphological diversity and morphometric characteristics of *Siganus* spp. in Tarakan's Beringin Market, which can be valuable for fisheries management, conservation efforts, and the sustainable use of this commercially important fish species. Future studies should explore the genetic diversity and population dynamics of Rabbitfish to complement the findings of this study and further inform management strategies.

Keywords: Morphological diversity, Morphometric analysis, *Siganus* spp., Rabbitfish, Fisheries management

INTRODUCTION

Rabbitfish (*Siganus* spp.) are demersal fish that inhabit the bottom or near-bottom waters of various aquatic ecosystems, commonly found in seagrass beds and coral reefs. They belong to the Siganidae family, which boasts a diverse

range of species distributed across numerous aquatic regions in Indonesia. According to El-Sadek et al. (2022), Rabbitfish primarily utilize seagrass beds as nurseries and growing grounds before migrating to surrounding ecosystems, such

as coral reefs, to spend a significant portion of their adult lives.

Data from the Ministry of Marine Affairs and Fisheries (KKP, 2018) shows an increase in Rabbitfish production from 2015 to 2017, with 47,930.57 tons in 2015 and 115,937.14 tons in 2017. However, in 2018, the production dropped to 97,615.49 tons. The high demand for Rabbitfish consumption has led to an increase in fishing activities, which could potentially cause a decline in their population within their natural habitats. Consequently, sustainable resource management is crucial for ensuring the long-term availability of Rabbitfish.

Accurate species identification is a fundamental aspect of resource management (Hanahara, 2021). Identification through morphological and morphometric characteristics involves examining and comparing the physical features of fish to distinguish between different species (Batubara *et al.*, 2018). Morphology refers to the study of the form and structure of organisms. In the context of fish, this includes characteristics such as body shape, fin shape, color patterns, and other external features. Morphometrics is the quantitative analysis of the shape and size of organisms. The increasing demand for Rabbitfish, coupled with the potential decline in their population due to overfishing, highlights the importance of sustainable resource management and conservation efforts. Investigating the morphological diversity and morphometric characteristics of Rabbitfish in the Beringin Market can provide valuable insights into the population structure and species identification of *Siganus* spp.

METHODOLOGY

Sampling Site

This study was conducted from May to November 2022. The sampling of Rabbitfish was carried out at Beringin Market in Tarakan. The morphological examination of Rabbitfish was performed at

the Fisheries Biology Laboratory of the Faculty of Fisheries and Marine Sciences, Borneo Tarakan University.

Methodes

During the morphological observation procedure, 30 Rabbitfish specimens were meticulously examined, emphasising discerning morphological traits such as body configuration, oral structure, caudal fin form and placement, and chromatic patterns. The morphological identification process followed Zuhdi dan Madduppa (2020) guidelines. After the species identification, documentation ensued.

The acquisition of morphometric data entailed directly observing and measuring 30 collected fish samples. Morphometric attributes encompassed measurements such as Total Length (TL), Standard Length (SL), Head Length (HL), Head Height (HH), Body Height (BH), Caudal Peduncle Height (CPH), Eye Diameter (ED), Interorbital Distance (IOD), Body Width (BW), Pre-dorsal Fin Length (PDFL), Pre-ventral Fin Length (PVFL), Pre-anal Fin Length (PAFL), Dorsal Fin Base Length (DFBL), Anal Fin Base Length (AFBL), Ventral Fin Base Length (VFBL), Upper Caudal Fin Length (UCFL), Lower Caudal Fin Length (LCFL), Pre-pectoral Fin Length (PPFL), Pectoral Fin Base Length (PFBL), Pre-pelvic Fin Length (PPFL), Fork Length (FL), Upper Jaw Length (UJL), and Lower Jaw Length (LJL) (Zuhdi & Madduppa, 2020).

Statistic Analysis

The morphometric character measurements procured from the Rabbitfish specimens will be analysed using a quantitative descriptive methodology. This analytical approach entails the systematic examination, evaluation, and representation of numerical data associated with the subject of investigation, aiming to derive meaningful conclusions that align with the observed phenomena during the study (Cooksey, 2020). The acquired data will be

exhibited in tabular format, encompassing pertinent information concerning the morphometric character measurements, including minimum, maximum, mean, and standard deviation values. Moreover, this comprehensive dataset will be juxtaposed with the morphometric attributes of Rabbitfish accessible on fishbase.com, facilitating a deeper understanding of potential discrepancies or unique findings that may emerge from the comparison.

RESULT AND DISCUSSION

Generally, the Rabbitfish examined in this study displayed various distinctive characteristics, including a laterally compressed body, a scaled area anterior to the ventral fin, a vast body, an emarginate caudal fin, a greyish-brown colouration, pale blue spots coalescing into wavy lines

on the ventral aspect, dark caudal fins, and a predominantly yellowish cheek region. Each fin comprises two distinct elements: a rigid and a flexible section, with the quantity varying according to the specific Rabbitfish species. Belonging to the Siganidae family, these fish are also referred to as rabbitfish due to their snouts resembling a rabbit's head. Rabbitfish typically inhabit coral reef surroundings and aggregate in groups, feeding on the algae attached to the reefs (Burhanuddin et al., 2014). This distinctive array of morphological traits emphasizes the importance of additional research into the morphological diversity of commercially traded Rabbitfish, concentrating on identifying potential variations among species and improving species-specific management and conservation initiatives.

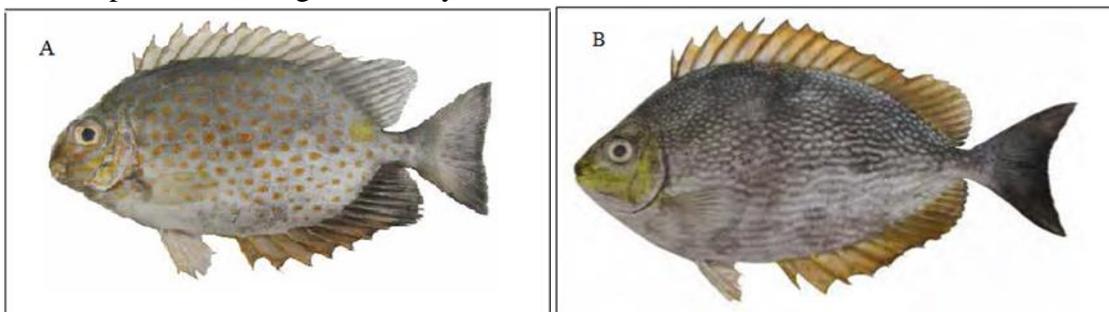


Figure 1. Illustration of Rabbitfish Species: (A) *Siganus guttatus*, and (B) *Siganus javus*

The observational study identified two distinct Rabbitfish species: *Siganus guttatus* and *Siganus javus*. As depicted in Figure 1, these species exhibit variances in characteristics such as body shape, fin structure, and caudal fin morphology. *Siganus guttatus* is characterized by a scaled chest region anterior to the ventral fin, an expansive body, silvery-blue colouring with prominent orange-brown spots, significant yellow markings beneath the final dorsal fin rays, a gilded head with blue striations extending from the oral cavity to the ocular region, and a cheek displaying a similar pattern. Conversely, *Siganus javus* presents a scaled abdomen preceding the ventral fin, a vast body, an emarginate caudal fin, a greyish-brown dorsal region accompanied by an array of

pale blue spots coalescing into undulating lines on the ventral aspect, dark caudal fins, and a primarily yellowish cheek zone. Consequently, both Rabbitfish samples are members of the Siganidae family, classified as *Siganus guttatus* and *Siganus javus* species. The characteristics of these fish samples are corroborated by observations documented in fish identification literature (White et al., 2013).

The results of the morphological analysis indicate that the Rabbitfish specimens procured from Beringin Market in Tarakan City exhibit similarities with those previously examined by Mahrus and Syukur (2020) in the waters of the southern sea surrounding Lombok Island, Parawansa et al. (2020) in the Takalar waters, and Indriyani et al. (2020) in the Sei Karang

Tanjung Pinang waters. The morphological analysis is substantiated by the morphometric data analysis derived from the measurements of 30 Rabbitfish samples, encompassing 17 *Siganus guttatus* and 13

Siganus javus individuals gathered from Beringin Market in Tarakan. The morphometric measurements are delineated in Table 1.

Table 1. Detailed Morphometric Assessment of Rabbitfish (*Siganus guttatus* and *Siganus javus*)

No	Measurement Point	Minimum (cm)		Maximum (cm)		Mean (cm)		Deviation Standard	
		A	B	A	B	A	B	A	B
1	Total Length (TL)	15,07	17,14	22,17	23,44	10,84	19,11	1,93	2,01
2	Standard Length (SL)	12,21	13,27	17,05	19,27	8,41	6,86	1,67	1,68
3	Head Length (HL)	2,83	3,4	4,66	4,97	2,31	1,85	0,46	0,41
4	Head Height (HH)	4,32	4,21	6,65	6,72	3,03	2,41	0,77	0,87
5	Body Height (BH)	6,52	5,51	8,57	9,66	4,31	3,41	0,53	1,06
6	Caudal Peduncle Height (CPH)	1,08	1,21	2,01	1,94	0,85	0,68	0,29	0,19
7	Eye Diameter (ED)	1,02	1,11	1,57	1,78	0,71	0,56	0,15	0,23
8	Interorbital Distance (IOD)	0,92	1,17	1,87	2,02	0,85	0,71	0,26	0,21
9	Body Width (BW)	1,28	1,34	2,38	2,69	1,05	0,81	0,34	0,37
10	Pre-Dorsal Fin Length (PDFL)	3,91	4,18	5,04	5,66	2,62	2,11	0,38	0,41
11	Pre-Ventral Fin Length (PVFL)	3,36	4,11	5,85	6,35	2,63	2,21	0,63	0,61
12	Pre-Anal Fin Length (PAFL)	6,82	6,54	8,98	9,66	4,56	3,51	0,64	0,97
13	Dorsal Fin Base Length (DFBL)	9,93	10,47	13,59	13,46	6,67	5,37	0,91	0,88
14	Anal Fin Base Length (AFBL)	5,55	6,17	8,27	9,54	4,05	3,41	0,89	1,07
15	Ventral Fin Base Length (VFBL)	1,53	1,45	3,07	3,42	1,11	0,81	0,36	0,51
16	Upper Caudal Fin Length (UCFL)	2,49	2,44	5,05	5,52	2,23	1,87	0,66	0,86
17	Lower Caudal Fin Length (LCFL)	2,33	2,28	4,87	5,37	2,21	1,76	0,75	0,89
18	Pre-Pectoral Fin Length (PPFL)	2,74	3,43	4,45	4,85	2,17	1,81	0,48	0,36
19	Pectoral Fin Base Length (PFBL)	2,49	2,66	7,83	8,65	3,57	2,82	1,56	2,13
20	Pre-Pelvic Fin Length (PPLF)	6,32	6,57	9,39	9,28	4,54	3,65	0,83	0,68
21	Caudal Peduncle Length (CPL)	15,17	15,12	20,59	22,42	10,33	8,37	1,57	2,31
22	Upper Jaw Length (UJL)	0,94	1,14	2,68	2,61	1,91	0,83	0,46	0,47
23	Lower Jaw Length (LJL)	0,83	1,12	2,38	2,33	0,96	0,73	0,39	0,39

Note: A = *Siganus guttatus*; B = *Siganus javus*

In the present study, the morphometric measurements of *Siganus guttatus* revealed variations in average total lengths and body widths. Woodland (1997) research reported a longer total length for *Siganus guttatus* commonly found at 25 cm. In contrast, the body width of 2.30 cm was narrower than the measurements observed in this study. Disparities in total length and body width can be ascribed to factors such as sex, age, and dietary intake. Regarding sex, male fish typically exhibit more extraordinary lengths than their female

counterparts. Fish in their juvenile stages tend to be shorter, while more mature fish display increased lengths, thus contributing to size variations. Furthermore, when abundant food resources, fish growth is optimized, enhancing length and weight (El-Sadek et al., 2022).

The morphometric measurement results reveal that *Siganus javus* in this study has a shorter mean total length, body width, and caudal peduncle length compared to the findings reported by Ghufroon & Kordi (2015), which were 26

cm, 2.03 cm, and 27 cm, respectively. As Jisr et al. (2018) noted, disparities in total length, body width, and caudal peduncle length may be attributable to internal and external factors. Internal factors encompass genetics, cell division, and age, while external factors include temperature, food

availability, disease, dissolved oxygen, genetics, and salinity. Table 2 presents a comparison of the morphological characteristics' percentages of *Siganus guttatus* and *Siganus javus* in terms of total length and head length between this study's findings and data from FishBase.com.

Table 2. Comparison of Morphological Characteristic Percentages with respect to Total Length (TL) and Head Length (HL) for Rabbitfish (*Siganus guttatus* dan *Siganus javus*)

No	Morphological Character	Percentage of TL (%)			
		This Research		Fishbase	
		A	B	A	B
1	Total Length (TL)	10,84 cm	19,11 cm	10,7 cm	16,5 cm
2	Standard Length (SL)	77,58 % TL	35,89 % TL	86,5 % TL	48,6 % TL
3	Caudal Peduncle Length (CPL)	95,29 % TL	43,79 % TL	98,0 % TL	39,9 % TL
4	Pre-Anal Fin Length (PAFL)	42,06 % TL	18,36 % TL	44,9 % TL	13,9 % TL
5	Pre-Dorsal Fin Length (PDFL)	24,16 % TL	11,04 % TL	21,1 % TL	19,00 % TL
6	Pre-Pelvic Fin Length (PPLF)	4,88 % TL	19,09 % TL	2,70 % TL	22,08 % TL
7	Pre-Pectoral Fin Length (PPFL)	20,01 % TL	19,47 % TL	21,6 % TL	17,4 % TL
8	Head Length (HL)	21,30 % HL	9,68 % HL	22,2 % HL	8,2 % HL
9	Eye Diameter (ED)	6,54 % HL	2,93 % HL	3,6 % HL	3,9 % HL

Note: A = *Siganus guttatus*; B = *Siganus javus*

In the present study, four morphological characteristics of *Siganus guttatus* displayed greater percentages than those recorded on FishBase.com, including total length, length before the dorsal fin, length before the pelvic fin, and eye diameter. Conversely, FishBase.com data indicated that five characteristics of *Siganus guttatus* were longer than those found in this study, namely standard length, caudal peduncle length, length before the anal fin, length before the pectoral fin, and head length. Jisr et al. (2018) proposed that factors such as temperature and dissolved oxygen could potentially influence fish body size variations. Elevated water temperatures may diminish dissolved oxygen levels, subsequently affecting fish respiration and feeding behaviors. Discrepancies between water temperature and fish body temperature can disrupt metabolism, leading to growth issues and body size variation due to digestive system complications. Dissolved oxygen in water is

a critical component for fish respiration and metabolic processes.

The percentage results for *Siganus javus* reveal five morphological characteristics with greater dimensions than those recorded on FishBase.com, including total length (TL), caudal peduncle length (CPL), pre-anal fin length (PAFL), pre-pectoral fin length (PPFL), and head length (HL). Conversely, the percentages for *Siganus javus* on FishBase.com exhibit four characteristics that surpass those found in this research, specifically standard length (SL), pre-dorsal fin length (PDFL), pre-pelvic fin length (PPLF), and eye diameter (ED). Each fish species presents unique absolute sizes, which can be influenced by environmental factors such as water temperature and salinity or by imbalanced genetic factors (Batubara et al., 2018).

Conclusion and Recommendation

This comprehensive study delved into the examination of Rabbitfish, leading to

the identification of two separate species, *Siganus guttatus* and *Siganus javus*, distinguished by their individual morphological traits. The assessment of these species' morphometric parameters exhibited discrepancies in total length, body width, and other aspects when juxtaposed with findings from earlier research and FishBase.com records. These differences can be linked to a wide range of factors, encompassing sex, age, nutritional habits, hereditary features, and environmental elements like ambient temperature, the presence of dissolved oxygen, and the degree of salinity in the water.

This investigation accentuates the necessity for continued exploration into the morphological diversity of Rabbitfish within commercial trade, with particular emphasis on discerning potential disparities among species to bolster management and conservation initiatives tailored to individual species. By grasping the elements that shape variations in size and morphological distinctions, researchers will be better equipped to supervise and regulate Rabbitfish populations, thereby promoting their sustainable use and preservation.

For future research, it is recommended to incorporate molecular analysis through DNA Barcoding techniques to complement morphological data, allowing for more accurate species identification and differentiation. Identification errors may occur if relying solely on morphological characteristics, as experienced by Gaffar *et al.* (2021) in identifying butterfly ray. Employing this method will not only bolster our comprehension of Rabbitfish classification but also aid in devising more successful conservation and management approaches. This is especially pertinent when addressing concerns pertaining to overfishing, the decline of habitats, and the ramifications of climate change on these essential species.

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Conflict Of Interest

Apart from one author who holds the position of editor-in-chief at the journal receiving this manuscript, the authors confirm that no conflicts of interest exist concerning this study. To ensure transparency and impartiality in the peer review and editorial procedures, this specific author has abstained from participating in any evaluative or decision-making aspects related to the manuscript. All other authors have been actively involved in the research's conception, execution, and reporting.

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