



Biometric Character of Chromis Fish in Indonesia and Korea

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ABSTRACT

There are more than 350 species of Chromis fish in the world. Its distribution covers tropical and subtropical water areas. Specific geographical conditions determine fish development. This study aims to analyze biometric characters, and to distinguish between chromis speies in Indonesia and Korea waters. The research analyzed 17 measured characters on the body of specimen collected and counted the number of spin and fin rays on the dorsal, ventral and caudal fin. The data were analyses descriptively, statically using Kruskal-Wallis, and Mann Whitney test. The result showed the total length of *Abudefduf sexfasciatus* found in Palabuhan ratu and Pramuka Island water territories are ranged from 9.9 to 10.2 cm and 7.7 to 13.0 cm. This species has a dorsal fin, caudal fin which consists of 12-17 fin rays, and ventral fin consists of one spine and 4-6 fin rays. *Abudefduf vaigiensis* found in Palabuhan ratu, Buton Island, Sorong, and Korea water has each ranging total length from 6.0 to 10.6 cm, 10.9 -12.3 cm, 11 cm, and 5.0 to 8.6 cm. The differences among the populations are in the caudal and ventral fin. Morphometric characters of *Abudefduf sexfasciatus* found in Palabuhan ratu and Pramuka Island water relatively similar. The study concluded that biometric characters of *Abudefduf vaigiensis* found in Korean waters was not significantly different with Palabuhan ratu, Buton Island, and Sorong water. Compared with the other two locations, *Abudefduf vaigiensis* found the island of Buton water territory has closely related family with the Korean water's

Keywords : *Abudefduf*, *chromis fish*, *populations*, *biometrics*

1. Introduction

One of ornamental fish found in the reef area is a chromis (family Pomacentridae). Chromis inhabit almost of all the sea waters in the world including Indonesia and Korea. In Indonesia, chromis are found in almost all waters, while in Korea are in the Yellow Sea, the Korean Strait, and the East Sea. Pearce et al. (2016) and Robert and Omond (1987) states there are more than 350 species of chromis in the world, and their distribution includes tropical and subtropical waters. The largest species groups is the genus *Hypsypops*, *Microspathodon*, and *Parma*. Chromis live on coral reefs, in average the size is 10 m with the smallest size found was 4-5 cm. Chromis that live in subtropical waters have various sizes. Each species has a different absolute size influenced by age, sex, and environment e.g. food, temperature, pH, and salinity.

In general, Chromis species groups has small and slanted mouth, dorsal fin interlock,

and the deep-shaped tail fin with a tapered puck. Cari referensi According to Pearce et al. (2011) and Picciulin et al (2010), Chromis have a fast swimming ability and can leave the larvae at a distance of 20 km. This fish will enforce its fins when disturbed, usually live by forming hordes or schooling with the main meal is plankton. Chromis have distinct morphological and morphometric characteristics among different species. *Abudefduf sexfasciatus* has a whitish body color with 5 black strips that thicken on the tail border. *Abudefduf bengalensis* has a grayish white skin with 6-7 black stripes, the shape of the tail is rounded and the color is dim. *Abudefduf vaigiensis* has a bluish-white color with a yellow color around the dorsal fin as well as 5 purplish or blue stripes on its body.

To avoid extinction and restore the presence of endangered species of fish domestication is urgently needed Yulfiperius (2006). Prior to domestication, the basic information of biometric relating to biology,

ecology and reproduction cycle should be understood. Morphometrics is a method of measuring the outer shape of the body as the basis for comparing the size of the fish, including width, total length (TL), eye diameter, standard length (SL), fish height, and others (Effendi, 2002). A comprehensive morphometric study in Asian catfish containing 28 valid species of 999 specimens and 35 measured characters showed that the analyses was congruent with molecular and osteological analyses (Gustiano and Pouyaud, 2005). While meristic is related to count characters. Both is known as biometrics in the modern taxonomy.

In fisheries biology, morphometric measurements are used to specify features and variation to detect the relationships in the fish stock population. According to Turan (1999), quantitative morphometric studies have four benefits: 1) to differentiating between sex and species; 2) to describe patterns of morphological diversity between populations; 3) to classify and suspect phylogenic and kinship relationships; And 4) to differentiate population among the same species from different geographic locations. According Gustiano (2004), biometric analysis enabled to distinguish between hybrids and parent stocks.

This study aims to analyze biometric character, and to distinguish between chromis species in Indonesia and Korea Waters.

2. Research Methods

Time of study and sampling Site

The research was conducted in September 2016 - February 2017 in Indonesia and Korea. Data were collected from four sampling sites in Indonesia: Palabuhanratu (West Java), Pramuka Island (DKI Jakarta), Buton Island (Southeast Sulawesi), and Sorong (West Papua).

Materials

Fish specimens used in this research were 22 samples of sergeant-majors fish (*Abudefduf* sp.) All specimens were grouped based on sex by examining secondary sexual characteristics such as differences in color, shape, and size and also by performing gonadal examination for the species without any sexual dimorphism (Takashashi and Hori, 2006).

Materials was used in this research e.g. chromis sample, formalin 4%-10% as preservative solution, tissue, ruler with precision 0.05 cm to measure biometric characters of

fish, digital scale to weight sample, plastics as sample layering, label paper, ice box. Analysis biometrics data used SPSS Program.

Method

The data collected in this study were morphometric data of chromis fish from the genus of *Abudefduf* sp. consisting of *Abudefduf sexfasciatus*, *Abudefduf vaigiensis* and *Abudefduf bengalensis*. Fish samples were taken from fishing activity using lines fishing gear in several coastal waters of Indonesia (Palabuhanratu, Pramuka Island, Buton Island, Sorong) and Korea (Jeju Island). Samples were stored in an ice box containing of formaldehyde 10%. Formaldehyde 4% were also infused into fish body through mouth or stomach in order to preserve the samples. Samples then were labeled according to fish information.

Samples were cleaned from formaldehyde and dried for measurement activity. Morphometric data was measured according to Haryono (2001). the total length (TL)(cm), fork length (FL) (cm), standard length (SL) (cm), body height (cm), caudal height (cm), caudal width (cm), head length (cm), eye diameter (cm), operculum length (cm), the eye to dorsal fin distance (cm), the snout to end of operculum distance (cm), the end of operculum to pectoral fin distance (cm), dorsal fin length (cm), dorsal fin height (cm), pectoral fin length (cm), pectoral fin height (cm), ventral fin length (cm), anal fin length (cm), caudal fin length (cm). The data were analyzed using. Kruskal-Wallis and Mann Whitney test. Descriptive analysis was also used to differentiate among population.

3. Result and discussion

Biometric of Abudefduf sexfasciatus and Abudefduf bengalensis

Abudefduf sexfasciatus (Lacpede 1801) is classified into Pomacentridae family. Its dominant characteristics are whitish body color with 5 black stripes on its body. This species has a thick black stripe on its caudal border. a dorsal fin, an anal fin, a pair of pectoral fins and fork shape of caudal fins. Its maximum total length (TL) is 16 cm. *Abudefduf bengalensis* can be identified by the characteristics of pale whitish-gray body color has 6-7 black stripes on its body and rounded and faint colored tail.

Morphometric data is listed on Table 1. *Abudefduf sexfasciatus* found in Palabuhanratu waters has a total length ranging from 9,9-10,2 cm, 8 spines and 12 rays on dorsal fin (D.VIII 12), 16 caudal rays (C.16), 16 pectoral rays (P.16), and one spine and 4-5 on ventral fin (V.

I 4-5). two spines and 10 rays on anal fin (A. II 10). The same species from the waters of Pramuka Island has more varied in total length, ranging from 7,7-13,0 cm, 8 spines and 7-10 rays on dorsal fin (D.VIII 7-10), 12-17 caudal rays (C. 12-17), 13-15 pectoral rays (P. 13-15) and one spine and 5-6 rays on ventral fin (V. I

5-6). Morphology character is more perfected by the increasing age in *Abudefduf sexfasciatus* to support its movement around the coral reefs. According to Pearce et al. (2011) and Smith et al. (2002), *Abudefduf sexfasciatus* juvenile lives in the open sea waters whereas the adult lives in coral reef area.

Table 1. Morphometric characters of *Abudefduf sexfasciatus* and *Abudefduf bengalensis*

No. Morphometric characters	<i>Abudefduf sexfasciatus</i>						<i>Abudefduf bengalensis</i>		
	Palabuhanratu			Pulau Pramuka			Sorong		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
1. Total Length (cm)	9,9	10,2	10,1	7,7	13,0	9,7	10,5	11,0	10,8
2. Fork length (cm)	8,1	8,3	8,2	6,7	11,0	8,2	9,2	10,0	9,6
3. Standard length (cm)	7,0	7,2	7,1	5,0	9,3	6,8	8,1	8,3	8,2
4. Body height (cm)	3,2	4,5	3,9	2,8	5,4	3,8	5,0	5,0	5,0
5. Caudal height (cm)	1,2	1,2	1,2	0,9	1,4	1,1	1,3	1,5	1,4
6. Caudal width (cm)	1,0	1,0	1,0	0,8	1,1	0,9	0,8	1,3	1,1
7. Head length (cm)	3,0	3,4	3,2	2,3	3,8	2,9	3,3	3,8	3,6
8. Eye diameter (cm)	0,6	0,8	0,7	0,5	0,8	0,6	0,7	0,7	0,7
9. Operculum length (cm)	0,6	0,7	0,7	0,6	0,9	0,7	0,8	0,9	0,9
10. The eye to dorsal fin distance (cm)	2,1	2,5	2,3	1,5	2,5	1,9	2,3	2,3	2,3
11. The snout to end of operculum distance (cm)	1,8	1,9	1,9	1,7	2,5	2,1	2,2	2,5	2,4
12. The end of operculum to pectoral fin distance (cm)	0,2	0,3	0,3	0,2	0,4	0,3	0,3	0,4	0,4
13. Dorsal fin									
A. Length (cm)	4,1	4,5	4,3	3,0	6,0	4,1	5,0	5,5	5,3
B. Height (cm)	1,6	1,9	1,8	1,3	2,3	1,7	1,5	2,2	1,9
14. Pectoral fin									
A. Length (cm)	2,1	2,2	2,2	1,2	2,7	1,9	2,0	2,5	2,3
B. Height (cm)	0,2	0,7	0,5	0,5	0,9	0,6	0,7	0,8	0,8
15. Ventral fin length (cm)	1,9	2,5	2,2	1,6	2,9	2,1	1,9	2,5	2,2
16. Anal fin length (cm)	1,6	2,2	1,9	1,5	2,3	1,8	1,9	2,3	2,1
17. Caudal fin length (cm)	2,6	3,4	3,0	2,3	3,2	2,8	2,3	3,0	2,7

Abudefduf sexfasciatus is commonly found in Indo-Pacific waters including Red Sea, East Africa, Madagascar, Persian Gulf, Sri Lanka, Bengal Bay, Andaman Sea, Indonesian waters and Australian waters. In Palabuhanratu, Thi species is found in coastal waters, whereas in Pramuka Island are found in coral reef area. The results is supported by previous publications That *Abudefduf sexfasciatus* likes, clean water, rocky reefs and migrate up to 15 meters deep (Pearce et al., 2016 and Damjanovic et al., 2015).

According to Picciulin et al. (2010) and Burhanuddin et al. (2013), generally *Abudefduf bengalensis* lives individually or in small groups in lagoon and shallow coral areas with depths of 1 - 6 m. *Abudefduf bengalensis* found in Sorong waters has a total length ranging from 11,0-11,5 cm, 8 spines and 4-12 rays on dorsal

fin (D.VIII 4-12), 14-16 caudal rays (C. 14-16), 15-18 pectoral rays (P. 15-18), one spine and 5 rays on ventral fin (V. I 5) and 2 spines and 2-12 rays on anal fin (A. II 2-12). Aside from Indonesia, these fish can also be found in the waters of Eastern Indian Ocean, Japan and Australia.

Biometric of Abudefduf vaigiensis

Chromis fish from *Abudefduf vaigiensis* species can be identified with a bluish-white body color with yellow color around its dorsal fin as well as 5 purplish or bluish stripes on the body. In addition, another characteristics of this fish are black spotted around the dorsal fin and has yellow eye color. The color of adult male fish body will turn more bluish during spawning. Compared to two other species, *Abudefduf*

vaigiensis are the most common during the research. The results of *Abudefduf vaigiensis* morphometric character analysis from

Indonesian and Korean waters are shown in Table 2.

Table 2. Meristic Morphometric of *Abudefduf vaigiensis*

No. Morphometric Characters	Palabuhanratu			Pulau Buton			Sorong	Korea		
	Min	Max	Mean	Min	Max	Mean		Min	Max	Mean
1. Total Length (cm)	6,0	10,6	8,4	10,9	12,3	11,3	11	5,0	9,6	6,3
2. Fork length (cm)	5,0	8,5	7,0	9,9	10,8	10,2	9,9	3,7	7,1	4,5
3. Standard length (cm)	4,7	7,7	6,3	8,3	9,2	8,7	8,7	5,9	6,6	6,2
4. Body height (cm)	2,4	4,3	3,4	4,5	5,3	4,8	5,2	5,0	5,8	5,3
5. Caudal height (cm)	0,6	0,9	0,7	1,3	1,5	1,4	1,5	1,5	1,8	1,7
6. Caudal width (cm)	0,7	1,3	1,0	0,9	1,5	1,0	1,5	1,6	1,9	1,7
7. Head length (cm)	2,1	3,9	3,1	3,2	4,0	3,6	3,5	3,2	3,7	3,5
8. Eye diameter (cm)	0,5	0,8	0,6	0,7	0,8	0,7	0,7	1,0	1,4	1,3
9. Operculum length (cm)	0,4	1,7	0,9	0,8	2,5	1,5	0,7	1,1	1,6	1,2
10. The eye to dorsal fin distance (cm)	1,2	2,5	1,8	2,1	2,6	2,4	2,1	2,5	3,3	2,9
11. The snout to end of operculum distance (cm)	1,4	2,3	1,8	2,1	2,4	2,3	2,5	3,3	3,7	3,6
12. The end of operculum to pectoral fin distance (cm)	0,1	0,4	0,2	0,2	0,3	0,2	0,2	0,3	0,5	0,4
13. Dorsal fin										
A. Length (cm)	3,3	4,9	3,9	5,0	5,7	5,3	2,3	5,5	6,5	5,8
B. Height (cm)	0,9	2,3	1,5	1,4	2,1	1,8	0,7	-	-	-
14. Pectoral fin										
A. Length (cm)	1,3	2,5	1,9	2,6	3,0	2,8	2,3	2,8	3,3	3,1
B. Height (cm)	0,3	0,7	0,5	0,7	0,9	0,8	0,7	-	-	-
15. Ventral fin length (cm)	1,2	2,5	2,0	2,1	2,9	2,5	2,2	2,3	3,5	2,9
16. Anal fin length (cm)	0,9	1,6	1,2	1,5	2,1	1,8	2,1	2,5	3,4	3,1
17. Caudal fin length (cm)	0,3	2,5	1,4	2,5	3,0	2,9	2,3	3,0	3,8	3,5

Abudefduf vaigiensis found in Palabuhanratu waters has a total length of 6,0-10,6 cm, the one found in Buton Island and Sorong waters has longer length, with TL ranging from 10,9-12,3 cm and 11 cm. While *Abudefduf vaigiensis* found in Korean waters has shorter length, with TL ranges from 5,0-9,6 cm, 8 spines and 12 rays on dorsal fin (D.VIII 12), 16 caudal rays (C.16), 14-20 pectoral rays (P. 14-20), one spines and 3-4 ventral rays (V. I 3-4) and 1 - 2 spines and 11-12 rays on anal fin (A. I-II 11-12). The dorsal fin of *Abudefduf vaigiensis* from the waters of Buton Island, Sorong, and Korea are relatively similar to that in Palabuhanratu waters. The differences can be seen in caudal fin, in which *Abudefduf vaigiensis* found in Buton Island has 18 caudal rays (C. 187), in Sorong has 14 caudal rays

(C.14), and in Korea has 19-21 caudal rays (C. 19-21).

The difference in caudal fin morphometric of *Abudefduf vaigiensis* from different waters is allegedly due to the structure and gap of coral reef in each location. *Abudefduf vaigiensis* tends to form a schooling while migrating in waters columns or rocky crevices and mostly found in areas along the coastline, outer slopes to a depth of 12 meters. Meanwhile, according to Picciulin et al. (2010) and Affandi (1992), caudal fin is the main propulsion for the fish to move forward and migrate to certain waters area. Differences are also seen in the ventral fin, where *Abudefduf vaigiensis* found in Palabuhanratu has 3-4 ventral rays, *Abudefduf vaigiensis* found in Sorong has 4-5 ventral rays and 5 ventral rays

from *Abudefduf vaigiensis* found in both Buton Island and Korea. The difference in the number of these soft rays will affect the stability of *Abudefduf vaigiensis* in all four locations. This is allegedly due to the location of ventral fins behind the nearest rectum, thus controlling the stability of forward motion/fish swimming (Vazzana et al., 2017 and Rodríguez-Fuentes et al., 2013). Aside from Indonesia and Korea, *Abudefduf vaigiensis* can also be found in Thailand Bay, Malaysia, the Philippines, and Japan, as well as Indo-Pacific including the Red Sea, the Gulf of Aden, Maladeva, Sri Lanka and the Andaman Sea.

Morphometric Character Comparison of *Chromis* fish from Indonesian and Korean Waters

Morphometric characters comparison of *Abudefduf sexfasciatus*

As mentioned above, *Abudefduf sexfasciatus* in this research was found in the waters of Palabuhanratu and Pramuka Island, Seribu Islands. The result of Kruskal-Wallis test for morphometric character comparison of *Abudefduf sexfasciatus* in both Palabuhanratu waters and Pramuka Island waters is presented in Table 3.

Table 3. Kruskal-Wallis test result from morphometric characters of *Abudefduf sexfasciatus*

Characters	Location	N	Mean Rank
Morphometric	1	19	20,18
	2	19	18,82
	Total	76	
Chi-Square		0,144	
df		1	
Asymp. Sig.		0,704	

Note : 1 = Palabuhanratu Waters, 2 = Pramuka Island Waters

In Table 4, there is no significant difference found in morphometric character between *Abudefduf sexfasciatus* found in both Palabuhanratu waters and Pramuka Island waters, Seribu Islands. This is indicated by the value of Asymp. Sig. > 0,05 (0,704). Kruskal-Wallis test also showed that there is similarity or close relation on *Abudefduf sexfasciatus* found in Palabuhanratu waters and Pramuka Island waters, Seribu Islands. This result is allegedly due to the same environmental conditions of *Abudefduf sexfasciatus* habitat in both waters area causing no significant changes in fish body. Damjanovic et al. (2015) stated that genetic similarity and environmental conditions are the dominant factors affecting the morphometric relationship of fish resources, although they are found in different locations. While the main habitat of *Abudefduf sexfasciatus* is a clear water region with many coral reefs.

Morphometric characters comparison of *Abudefduf vaigiensis*

In contrast to *Abudefduf sexfasciatus*, sergeant-majors fish from *Abudefduf vaigiensis* species were found in four research sites (out of the five research sites), namely Palabuhanratu, Sorong, Buton and Korea waters. This species inhabits good coral reefs covering by high coral. This condition is the reason for morphometric polymorphism of *Abudefduf vaigiensis* in various locations. The results of the morphometric comparison of *Abudefduf vaigiensis* in both Indonesian and Korean waters is presented in Table 4.

The result of Kruskal-Wallis test showed Asymp. Sig > 0,05 (0,614) (Table 5). This indicated that there is no significant difference in the morphometric character of *Abudefduf vaigiensis* found in the waters of Palabuhanratu, Sorong, Buton Island, and Korea. Table 5 only explains the overall comparison but not in detailed comparison between one and another location. To elaborate differences in morphometric characters between locations, the Mann-Whitney test was applied at Table 55)

Table 4. Kruskal-Wallis test on morphometric characters of *Abudefduf vaigiensis* from different sampling sites

Characters	Location	N	Mean Rank
Morphometrics	1	19	33,32
	3	19	41,29
	4	19	37,61
	5	19	41,79
Total		76	
Chi-Square		1,805	
df		3	
Asymp. Sig.		0,614	

Note : 1=Palabuhanratu Waters , 3=Buton Island, 4=Sorong Waters and , and 5=Korean Waters

Table 5. Mann Whitney test on morphometric chracters of *Abudefduf vaigiensis* from different sampling sites

Parameter	Comparison of Morphometric Characters					
	Location 1 vs 3	Location 1vs 4	Location 1 vs 5	Location 3 vs 4	Location 3 vs 5	Location 4 vs 5
Mann-Whitney U	142,500	150,500	150,000	157,000	172,000	157,000
Wilcoxon W	332,500	340,500	340,000	347,000	362,000	347,000
Z	-1,110	-0,877	-0,891	-0,688	-0,248	-0,687
Asymp. Sig. (2-tailed)	0,267	0,380	0,373	0,492	0,804	0,492
Exact Sig. [2*(1-tailed Sig.)]	0,271 ^b	0,385 ^b	0,385 ^b	0,506 ^b	0,817 ^b	0,506 ^b

Note: 1=Palabuhanratu Waters , 3=Buton Island, 4=Sorong Waters and , and 5=Korean Waters

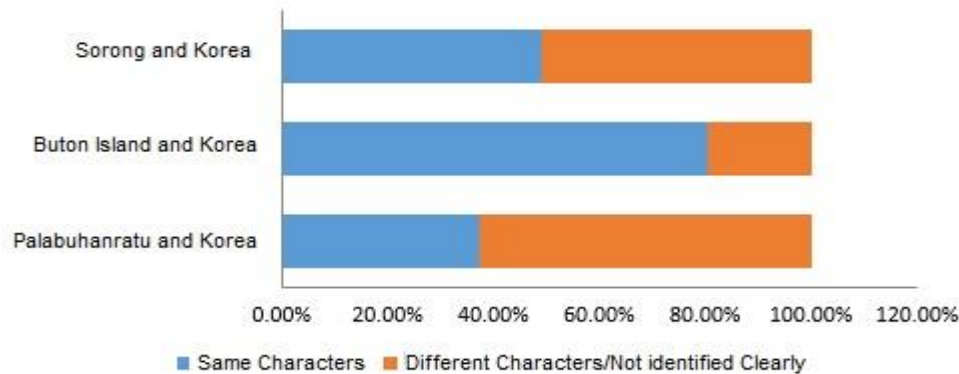


Figure 1. Similarity between *Abudefduf vaigiensis* found in Indonesian Waters and found in Korean Waters

Table 5 showed that there is no significant difference (A symp. 0.267; 0.380; 0.492; $P > 0.05$) among different populations of *Abudefduf vaigiensis* in Indonesian Waters (Palabuhanratu Waters, Buton Island, Sorong Waters). No significant difference was also occurred between populations of *Abudefduf vaigiensis* from Indonesian Waters (Palabuhanratu Waters, Buton Island, Sorong Waters) and Korean waters. These results showed that there are similarities or between *Abudefduf vaigiensis* found in the waters of Palabuhanratu, Buton Island, Sorong, and Korea. According to Damjanovic et al. (2015) and Pearce et al. (2011), morphometric close relation is an indication of similar behavior, adaptation, and fish migration pattern toward aquatic environment. Meanwhile, according to Pearce et al. (2016) and Haryono (2001), suitable and stable environmental conditions can help in maintaining fish morphometric conditions and fish mating cycles. Similarity among populations from Indonesia and Korea is given on Figure 1.

Based on Table 3, Table and Figure 1, *Abudefduf vaigiensis* from Buton has high degree similarity to Korea one rather than others population from Indonesian Waters. Those analysis given in Table 4&6 and Figure 1 are congruent each others. Shorter distance between Buton Island and Korea Waters compare to other location of sampling sites is another reason of the high similarity. According to Pearce et al. (2011) and Mohapatra et al. (2015), longitude based location also affects the characteristics of the aquatic component, although not as great as the influence from latitude based location. Rodríguez-Fuentes et al. (2013) and Booth et al. (2007) mentioned longitudinal position determines the time of sun exposure, which influences the pattern of sea

water temperature change, eating habits, recruitment, local adaptation patterns of coral reef fish.

4. Conclusion

The conclusions of this research are:

1. Fish *Abudefduf sexfasciatus* found in the waters of Palabuhanratu has a total length of 9.9 to 10.2 cm and in Pramuka island waters has 7.7 - 13.0 cm. *Abudefduf sexfasciatus* in Palabuhanratu and Pulau Pramuka waters have a single dorsal fin, caudal fin consists of 12-17 weak fingers, and ventral fin consists of 1 hard fingers and 4 - 6 weak fingers. *Abudefduf vaigiensis* fish found in Palabuhanratu, Buton, Sorong, and Korea waters have a total length of 6.0 - 10.6 cm, 10.9 - 12.3 cm, 11 cm, and 5.0 to 8.6 cm respectively. Differences were seen in caudal fin and ventral fin.
2. The morphometric character of *Abudefduf sexfasciatus* found in the waters of Palabuhanratu and Pramuka Island was similar. The morphometric character of *Abudefduf vaigiensis* found in Korean waters is not significantly different from that of Palabuhanratu, Buton Island waters), and Sorong waters. Compared to the other two sites, the *Abudefduf vaigiensis* fish found in the waters of Buton Island have similarity found in Korean waters.

5. Suggestion

To strengthen the result of this study further research on genetics to clarify the relationship of kinship in Indonesian and Korean waters.

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