Truss Morphometric and Meristic Characters of Male and Female Donkey Croaker (*Penahia anea* (Bloch 1793)) Taken from Asemdoyong Auction Center Pemalang, Central Java

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ABSTRACT

Pennahia anea is among of the demersal fish landed at Asemdoyong Fish Auction Centre, Pemalang. P. anea doesn't show sexual dimorphism, so that other characters are needed to differentiate male and female individuals, i.e. truss morphometric and meristic characters. Previous studies have shown that truss morphometric and meristic can differentiate between male and female individuals. This study aims to describe the morphometric and meristic truss characters and determine the truss morphometrically and meristic characters that distinguish between males and females of Pennahia anea. The research used a survey method with a purposive random sampling technique. Male and female individuals were examined based on their meristic and truss morphometric characters. The data were analyzed statistically using Mann Whitney non-parametric test. The result proved that male and female were significantly different in seven out of the 31 truss distances. Male individuals had a larger size than female individuals in three truss distances. In contrast, the male had a smaller size than the female individuals in four out of seven truss distances that distinguish both sexualities. The soft fin radius of the ventral fin was significantly different between male and female of P. anea. It could be concluded truss morphometric and meristic characters could differentiate fame and female individuals of Pennahia anea.

Introduction

Indonesia is a maritime country with the second-longest coastline (108,000 km) (Peristiwady, 2019). Pemalang coastline is part of the Indonesia coastline that resides in the North of Central Java with approximately 35 km (Waridin, 2007). This regency has five Fish Auction Centers (TPI), and the largest is TPI Asemdoyong (Karningsih *et al*., 2014). Many fish species have been landed in Asemdoyongs' Fish Auction Center, one of which is *P. anea*. That fish species has a common name Donkey Croaker (Ernawati & Bambang, 2010).

Donkey Croaker is distributed in tropical and subtropical regions and abundant in the Indian Ocean (Wagiyo *et al*., 2020). The maximum body size found in China, Thailand, the Philippines, Malaysia, and Indonesia was 300 mm. However, *P. anea* that live in the Indian and Pacific Oceans has a maximum body size of 400 mm (Tuuli *et al*., 2011). *P. anea* belongs to the demersal fish group (Baransano & Mangimbulude, 2011). This species lives in coastal waters with a depth of up to 60 meters and commonly found in muddy water (Wagiyo *et al*.,

2020). *P. anea* has a high economic value. Its meat is consumed as a protein source, and the swim bladder is sold at a high price because of its good health benefits (Tuuli *et al*., 2011).

The morphological characters of *P. anea* are pointed snout, large mouth, and no barbells. It has two pairs of a tiny pore. The first pair of pores are in front of the chin, separated by symphysis. The upper teeth are larger than the lower teeth, do not have canine, the abdomen has a white colour, the caudal fin is truncate, and has 22-25 soft dorsal fins (White *et al*., 2013). *P.anea* is fish species that do not show sexual dimorphisms. In such case, male and female fish can only be distinguished by observing their gonads through dissection. However, that technique is not reliable for immature individuals, where gonads are not fully developed. Male and female immature fish individuals can be differentiated using truss morphometric and meristic characters (Wijayanti *et al*., 2017).

Truss morphometric observes all distances between truss points on the body, then compared with standard lengths to obtain a constant value even though the observed fish size varies (Onsoy *et al*., 2011). Meristic is a method of counting characters, which is done by counting certain body parts. Usually, the part of the body that calculated as the number of hard and soft rays on the dorsal, caudal, anal, ventral, pectoral fin, and the number of scales on the lateral line (Radona *et al*., 2017). Meristic characters can be affected by environmental factors such as water salinity, water temperature, and dissolved oxygen in the water, which affects the growth process of fish larvae, so there may be different characters when the fish are adults (Resmayeti, 1994).

The previous study had proven the reliability of truss morphometric and meristic characters for distinguishing male or female fish individuals (Auliana *et al*., 2017). Auliana *et al*. (2017) found that the distance between the tip of the snout and the dorsal part of the border between head and body can distinguish male and female Tontobi fish (Nematalosa erebi). At the same time, the number of fin ray in the anal fin is also a distinguishing character.

This study aimed to describe truss Morphometric and Meristic characters of male and female individuals of Donkey Croaker (*Pennahia anea*) and to determine which characters can distinguish male and female of Donkey Croaker (*Pennahia anea*).

Materials and Methods

Sampling site and times

We focused on *Pennahia anea* that landed in Asemdoyong Fish Auction Center Pemalang Central Java. According to the research focus, fish samples collected from fish seller at the auction centre (Figure 1). The samples collected in April and May 2020.

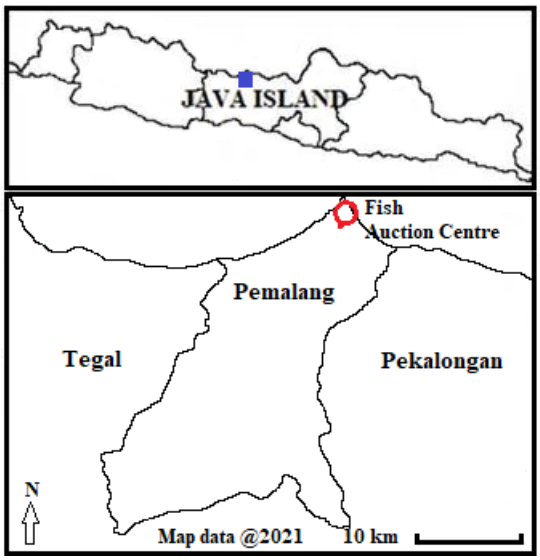

Figure 1. Sampling sites in the Asemdoyong Fish Auction Centre Pemalang, Central Java

Fish handling and identification

Fresh individual fish samples were placed in cooler boxes to keep their morphological performances and colour. Upon arrival in the laboratory, the specimens were put in a freezer at -20°C until further examination. Trus morphometrics characters, standard and head length, were measured using a calliper with an accuracy of 0.001 cm. Truss morphometric measurements were conducted between 16 benchmark points and 31 truss distances (Figure 2). The truss distances were summarized in Table 1. The meristic characters were the number of gill rakers, the number of hard and soft rays on the dorsal, caudal, anal, ventral, and pectoral fins, the number of scales on the lateral line, the number of scale above the lateral line, and the number of scale under the lateral line. A total of 16 meristic characters were compared between male and female individuals.

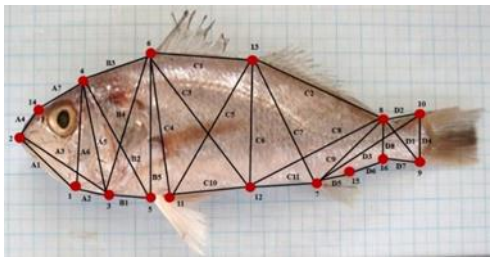

Figure 2. Truss Morphometric Characters Observed in Donkey Croaker (*Pennahia anea*)

Conventional identification was performed to ensure the taxonomic status of the samples. Identification was following the identification book from White et al. (2013), Carpenter and Niem (2001), and Saanin (1984). The validity of obtained scientific names was referred to the database available in FishBase (Froese and Pauly, 2021). Phylogenetic analysis was performed through phylogenetic tree or cladogram reconstruction. The cladogram was reconstructed based on 24 morphological characters, divided into three groups of characters; the ratio between two morphometrics measure, meristic, and general morphology performance. Morphometric characters refer to Ducic (2005). Detail characters used for phylogenetic analysis summarized in Table 1.

Data analysis

Data of truss distance and meristic characters, compared with the standard length, were analyzed using the "Mann-Whitney" test using SPSS software to distinguish male and female fish. The test was based on a 95% significance level or asymptote significance value of 0.05. The sexuality of the fish specimens was determined through dissection. Fish was dissected from the beginning anus to the anterior part of the stomach until to behind the operculum and dissected to the ventral part using surgical scissors. Dissection was performed carefully so as not to damage the internal organs, especially the gonads. The gonad topography was observed compared to the gonad topography of fish in Sukamto *et al.* (2010).

Results and Discussion

The total number of individuals fish samples used in this research was 53. The total length of fish samples ranges from 11.33 to 20.25 cm, while the weight ranges from 18.98 to 60.25 grams. According to Carpenter & Niem (2001), *P. anea* can grow up to 30 cm in length. According to Carpenter & Niem (2001) and White *et al*. (2013), Fish sample identification was conducted. It was proved that all the collected fish from TPI Asemdoyong belong to *P. anea*.

The morphological character of fish samples was fusiform with lateral line scales reaching the caudal fin's hind margin (Carpenter & Niem, 2001). The body colour was silvery grey, with the tip of the dorsal fin blackish. The observed colour is following White *et al*. (2013), who stated that *P. anea* has a fusiform body shape, with silvery grey body colour. According to Carpenter & Niem (2001), *P. anea* has a grey head and body. The abdomen is paler with silvery reflection.

The shape of the caudal fin is truncated (Figure 4.2. (a)). The type of scale is ctenoid (Figure 4.2. (b)), but there are cycloid scales on the head (Figure 4.2. (c)). The mouth position is terminal (Figure 4.2. (d)) and has small teeth on the lower jaw and large teeth without large fangs in the upper jaw (Figure 4.2. (e)). The observed characters follow Carpenter & Niem (2001) statement that *P. anea* has cycloid scales on its head, and in other parts, it has ctenoid scales. White *et al*. (2013) stated that this species has large upper teeth without large canines. Other morphological characters that distinguish *P. anea* from different species don't have a barbell and have two pairs of mental pores (Figure 4.2. e)). According to Carpenter & Niem (2001), these two pairs of mental pores are small. Based on Zhu *et al*. (1975), Sciaenidae generally has pores at the tip of the snout and lower jaw.

Table 1. Morphological characters used in phylogenetic analysis of pomacentrid fish.

Part	Body Part	No	Code	Annotation
A	Head	1	A1 (1-2)	The distance between the base points of the lower jaw and The tip of the snout
		2	A2 (1-3)	The distance between the base point of the lower jaw and The border between head and body (ventral part)
		3	A3 (2-3)	The distance between the tip of the snout and The border between head and body (ventral part)
		4	A4 (2-14)	The distance between the tip of the snout and The prominent part of the head
		5	A5 (3-4)	The distance between the border between head and body (ventral part) and The border between head and body (dorsal region)
		6	A6 (4-1)	The distance between the border between head and body (dorsal part) and The base point of the lower jaw
		7	A7 (4-14)	The distance between the border between head and body (dorsal part) and The prominent part of the head
B	Anterior	8	B1 (3-5)	The distance between the border between head and

Part	Body Part	No	Code	Annotation
	Part of the Body			body (ventral part) and The front base of the ventral fin
		9	B2 (4-5)	The distance between the border between head and body (dorsal part) and The front base of the ventral fin
		10	B3 (4-6)	The distance between the border between head and body (dorsal part) and The front base of the 1st dorsal fin
		11	B4 (6-3)	The distance between the front base of the 1st dorsal fin and The border between head and body (ventral part)
		12	B5 (6-5)	The distance between the front base of the 1st dorsal fin and The front bottom of the ventral fin
C	Posterior Part of the Body	13	C1 (6-13)	The distance between the front base of the 1st dorsal find and The front bottom of the 2nd dorsal fin
		14	C2 (13-8)	The distance between the front base of the 2nd dorsal fin and The back base of the 2nd dorsal fin
		15	C3 (6-12)	The distance between the front base of the 1st dorsal fin and The midway between the ventral and anal fins
		16	C4 (6-11)	The distance between the front base of the 1st dorsal fin and The back base of the ventral fin
		17	C5 (11-13)	The distance between the back base of the ventral fin and The front bottom of the 2nd dorsal fin
		18	C6 (12-13)	The distance between the midway between the ventral and anal fin and The front base of the 2nd dorsal fin
		19	C7 (13-7)	The distance between the front base of the 2nd dorsal fin and The front bottom of the anal fin
		20	C8 (8-12)	The distance between the back base of the 2nd dorsal fin and The midway between the ventral and anal fin
		21	C9 (8-7)	The distance between the back base of the 2nd dorsal fin and The front bottom of the anal fin
		22	C10 (11-12)	The distance between the back base of the ventral fin and The midway between the ventral and anal fin
		23	C11 (12-7)	The distance between the midway between the ventral and anal fin and The front base of the anal fin
D	Cauda	24	D1 (7-9)	The distance between the front base of the anal fin and The ventral folds of the tail
		25	D2 (8-9)	The distance between the back base of the 2nd dorsal fin and The ventral folds of the tail
		26	D3 (8-10)	The distance between the back base of the 2nd dorsal fin and The dorsal folds of the tail
		27	D4 (10-7)	The distance between the dorsal folds of the tail and The front base of the anal fin
		28	D5 (10-9)	The distance between the dorsal folds of the tail and The ventral folds of the tail
		29	D6 (7-15)	The distance between the front base of the anal fin and The back base of the anal fin
		30	D7 (16-9)	The distance between the curved part of the tail (ventral aspect) and The ventral folds of the tail
		31	D8 (8-16)	The distance between the back base of the 2nd dorsal

Part	Body Part	No	Code	Annotation
				fin and The curved part of the tail (ventral aspect)

Observation of gonads in *P. anea* showed that male gonad was elongated, milky white, and a pair. The female gonad was elongated, yellowish to orange, and the number was a pair (Figure 3). Both male and female gonads are located under the swim bladder. The characters follow Burhanudin (2008) statement that the fish gonads are a pair, with the colour and size according to the level of maturity of the gonads. The gonads are elongated, located laterally or ventrally to the swim bladder. The male gonads (testes) are whitish, while the female gonads (ovaries) are reddish-yellow.

The results of measuring the ratio between the truss distance and the standard length and tested using the "Mann Whitney" are presented in Table 2. It is summarized in Table 2 there were 7 out of 31 characters that the Asymptote Significance value less than 0.05. It was clear that the ratio of the truss distance that distinguishes male and female *P. anea* are A1, A3, B4, C8, C9, D3, and D5 (Figure 4). Based on Tuuli *et al*. (2011), *P. anea* is a gonochoric. Gonochoris is each individual has one genital (male or female). Tuuli *et al*. (2011) stated that the minimum size of gonad maturity for female *P. anea* was 125 mm in standard length, whereas, for males, it was 119 mm.

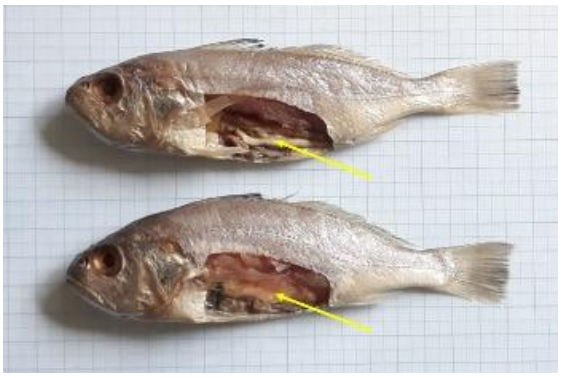

Figure 3. Gonad of *Pennahia anea* (a) Male Gonad; (b) Female

Table 2. The significance value of the Mann Whitney test of truss distance between male and female individuals

No	Truss	Mean Rank		Asymp. Sig	Mann Whitney Test
		M	F		
1	**A1**	**19,23**	**32,52**	**0,002**	*****
2	A2	26,95	27,03	0,986	NS
3	**A3**	**21,77**	**30,71**	**0,038**	*****
4	A4	30,45	24,55	0,170	NS
5	A5	24,41	28,84	0,304	NS
6	A6	26,14	27,61	0,732	NS
7	A7	29,36	25,32	0,348	NS
8	B1	27,59	26,58	0,814	NS
9	B2	24,82	28,55	0,386	NS
10	B3	22,59	30,13	0,080	NS
11	**B4**	**21,91**	**30,61**	**0,043**	*****
12	B5	24,73	28,61	0,367	NS
13	C1	26,50	27,35	0,843	NS
14	C2	31,68	23,68	0,063	NS

15	C3	25,14	28,32	0,459	NS
16	C4	24,73	28,61	0,367	NS
17	C5	26,00	27,71	0,691	NS
18	C6	25,73	27,90	0,613	NS
19	C7	25,18	28,29	0,470	NS
20	**C8**	**32,68**	**22,97**	**0,024**	*****
21	**C9**	**33,73**	**22,23**	**0,008**	*****
22	C10	25,50	28,06	0,551	NS
23	C11	27,64	26,55	0,800	NS
24	D1	26,05	27,68	0,705	NS
25	D2	25,23	28,26	0,481	NS
26	**D3**	**32,59**	**23,03**	**0,026**	*****
27	D4	26,55	27,32	0,857	NS
28	**D5**	**32,68**	**22,97**	**0,024**	*****
29	D6	30,09	24,81	0,220	NS
30	D7	26,50	27,35	0,843	NS
31	D8	24,91	28,48	0,406	NS

Note: M= male, F= female

The A1 character is the distance between the base points of the lower jaw and the tip of the snout. In male fish, the value was 19.23. In female fish, the value was 32.53. The A3 character is the distance between the tip of the snout and the ventral part of the border between head and body. In males, the value was 21.77. In female fish, the value was 30.71. The B4 character is the distance between the front base of the 1st dorsal fin and the ventral part of the border between head and body. In males, the value was 21.91. In female fish, the value was 30.61. It was observed that the male individual has a shorter distance than the female individual for those three truss characters.

In contrast, the male individual has a longer truss distance than the female individual for C8, C9, D3, and D5 truss characters. The C8 character is the distance between the back base of the 2nd dorsal fin and the midway between the ventral and anal fin. In males, the value was 32.68. In female fish, the value was 22.97. The C9 character is the distance between the back base of the 2nd dorsal fin and the front bottom of the anal fin. In males, the value was 33.73. In the female, the value was 22.23. The D3 character is the distance between the dorsal folds of the tail and the front base of the anal fin. In the male, the value was 32.59. In the female, the value was 23.03. The D5 is the distance between the front base of the anal fin and the back base of the anal fin. In males, the value was 32.68. In the female, the value was 22.97. From the results of data analysis, it was found that female *P. anea* has a longer anterior body, while male *P. anea* has a longer posterior body.

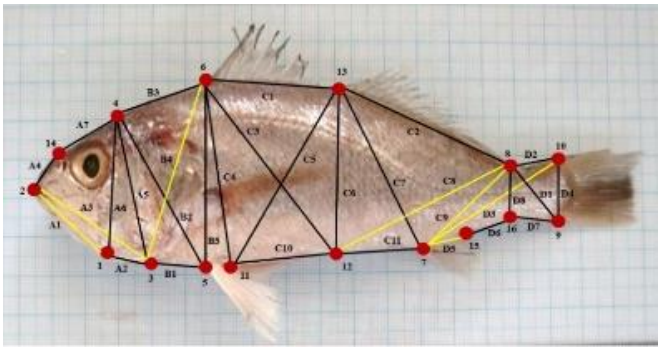

Figure 4. A significant difference in truss distance between male and female individuals. Note: The Yellow Line was Significant, and The Black Line was Non-Significant

A similar study by Sukmaningrum *et al*. (2020) found that the truss morphometric characters that differentiate male and female Oxeye Scad (*Selar boops*) were B1, B4, B9, D2, and D5. The B1 character is the ratio of the truss distance between the dorsal part of the border between head and body and the base of the anal fin. The B4 character is the ratio of the truss distance between the dorsal part of the border between head and body and the bottom of the anal fin. The B9 character is the truss distance between the front base of the 1st dorsal fin and the front base of the anal fin. The D2 character is the ratio of the truss distance between the back base of the anal fin and the dorsal fold of the tail. It was observed that the male individual has a shorter length than the female individual for those four characters. In contrast with the D5 character, the male individual has a longer distance than the female individual. The D5 character is the ratio of the truss distance between the ventral fold of the tail and the dorsal fold of the tail.

The result of the calculation of meristic characters is presented in Table 3 From these results, it is known that *P. anea* has fin formula D1.VIII-10; D2.I.22-25; C.17-20; A.II.7-8; V.I.4-5; P.14-17. The number of scales on the lateral line was 50 to 53. The number of scales above the lateral line was 6 to 8. The number of scales below the lateral line was 12 to 15. Carpenter & Niem (2001), *P. anea* has 9 to 10 hard fin rays on the 1st dorsal fin and one hard ray on the 2nd dorsal fin with 22 to 24 soft rays. The anal fin has two hard rays and seven soft rays.

Table 3. The significance value of the Mann Whitney test of meristic character between male and female individuals

No	Meristic	Mean Rank		Asymp. Sig.	Whitney Test
		M	F		
1	D1H	23.73	29.32	0.141	NS
2	D1S	27.00	27.00	1.000	NS
3	D2H	27.00	27.00	1.000	NS
4	D2S	27.50	26.65	0.829	NS
5	CH	27.00	27.00	1.000	NS
6	CS	29.89	24.95	0.195	NS
7	AH	27.00	27.00	1.000	NS
8	AS	28.75	25.76	0.418	NS
9	VH	27.00	27.00	1.000	NS
10	**VS**	**29.50**	**25.23**	**0.050**	*****
11	PH	27.00	27.00	1.000	NS
12	PS	25.07	28.37	0.415	NS
13	SoLL	23.57	29.44	0.155	NS
14	SaLL	27	27	1.000	NS
15	SbLL	23.86	29.23	0.182	NS
16	GR	24.55	28.74	0.282	NS

Conclusion

Based on the result and discussion, it can be concluded that male and female individuals of *Pennahia anea* have different morphology. Seven truss distances and one meristic character can distinguish male and female individuals of *Pennahia anea*.

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Truss Morphometric and Meristic Characters of Male and Female Donkey Croaker (*Pennahia anea* (Bloch 1793)) Taken from Asemdoyong Auction Center Pemalang, Central Java

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ABSTRACT

Pennahia anea is among of the demersal fish landed at Asemdoyong Fish Auction Centre, Pemalang. P. anea doesn't show sexual dimorphism, so that other characters are needed to differentiate male and female individuals, i.e. truss morphometric and meristic characters. Previous studies have shown that truss morphometric and meristic can differentiate between male and female individuals. This study aims to describe the morphometric and meristic truss characters and determine the truss morphometrically and meristic characters that distinguish between males and females of Pennahia anea. The research used a survey method with a purposive random sampling technique. Male and female individuals of P. anea were examined based on their meristic and truss morphometric characters. The data were analyzed statistically using Mann Whitney non-parametric test. The result proved that male and female were significantly different in seven out of the 31 truss distances. Male individuals had a larger size than female individuals in three truss distances. In contrast, the male had a smaller size than the female individuals in four out of seven truss distances that distinguish both sexualities. The soft fin radius of the ventral fin was significantly different between male and female of P. anea. It could be concluded that male and female individuals of Pennahia anea have different truss distances and meristic characters with seven truss distances and one meristic character are different.

Introduction

Indonesia is a maritime country with the second-longest coastline (108,000 km) (Peristiwady, 2019). Pemalang coastline is part of the Indonesia coastline that resides in the North of Central Java with approximately 35 km (Waridin, 2007). This regency has five Fish Auction Centers (TPI), and the largest is TPI Asemdoyong (Karningsih *et al*., 2014). Many fish species have been landed in Asemdoyongs' Fish Auction Center, one of which is *Pennahia anea*. *Pennahia anea* has a common name Donkey Croaker (Ernawati & Bambang, 2010).

Donkey Croaker is distributed in tropical and subtropical regions and abundant in the Indian Ocean (Wagiyo *et al*., 2020). The maximum body size found in China, Thailand, the Philippines, Malaysia, and Indonesia was 300 mm. However, *P. anea* that live in the Indian and Pacific Oceans has a maximum body size of 400 mm (Tuuli *et al*., 2011). *P. anea* belongs to the demersal fish group (Baransano & Mangimbulude, 2011). This species lives in coastal

waters with a depth of up to 60 meters and commonly found in muddy water (Wagiyo *et al*., 2020). *P. anea* has a high economic value. Its meat is consumed as a protein source, and the swim bladder is sold at a high price because of its good health benefits (Tuuli *et al*., 2011).

The morphological characters of *P. anea* are pointed snout, large mouth, and no barbells. It has two pairs of a tiny pore. The first pair of pores are in front of the chin, separated by symphysis. The upper teeth are larger than the lower teeth, do not have canine, the abdomen has a white colour, the caudal fin is truncate, and has 22-25 soft dorsal fins (White *et al*., 2013). *P.anea* is fish species that do not show sexual dimorphisms. In such case, male and female fish cannot be easily differentiated morphologically without specific technique. The only technique can be distinguished male and female individual is by observing their gonads through dissection. However, that technique is not reliable for immature individuals, where gonads are not fully developed. According to Wijayanti *et al*. (2017), male and female immature fish individuals can be differentiated using truss morphometric and meristic characters. Therefore, this study tried to evaluate the possibility of using truss morphometric and meristic characters to distinguish male and female of *P. anea*.

Truss morphometric observes all distances between truss points on the body, then compared with standard lengths to obtain a constant value even though the observed fish size are varies (Onsoy *et al*., 2011). Meristic is a method of counting characters, which is done by counting certain body parts. Usually, the part of the body that calculated as the number of hard and soft rays on the dorsal, caudal, anal, ventral, pectoral fin, and the number of scales on the lateral line (Radona *et al*., 2017). Meristic characters can be affected by environmental factors such as water salinity, water temperature, and dissolved oxygen in the water, which affects the growth process of fish larvae, so there may be different characters when the fish are adults (Resmayeti, 1994). The previous study had proven the reliability of truss morphometric and meristic characters for distinguishing male or female fish individuals (Auliana *et al*., 2017). Auliana *et al*. (2017) found that the distance between the tip of the snout and the dorsal part of the border between head and body can distinguish male and female Tontobi fish (Nematalosa erebi). At the same time, the number of fin ray in the anal fin is also a distinguishing character.

This study aimed to differentiate truss distances and meristic characters of male and female individuals of Donkey Croaker (*Pennahia anea*) and to determine the number of truss distances and meristic characters can distinguish male and female of Donkey Croaker (*Pennahia anea*).

Materials and Methods

Sampling site and times

We focused on *Pennahia anea* that landed in Asemdoyong Fish Auction Center Pemalang Central Java. According to the research focus, fish samples collected from fish seller at the auction centre (Figure 1). The samples collected in April and May 2020.

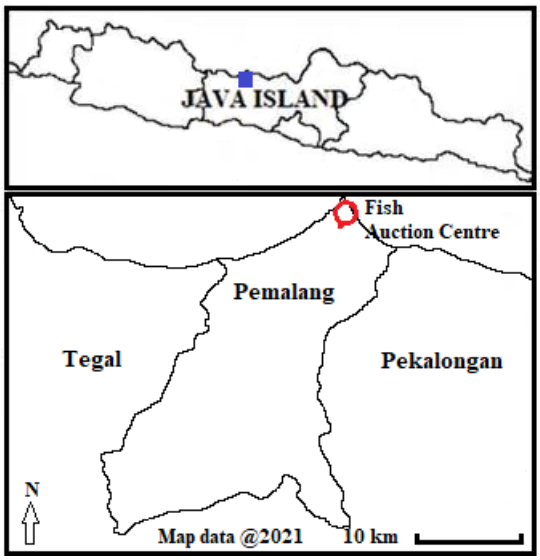

Figure 1. Sampling sites in the Asemdoyong Fish Auction Centre Pemalang, Central Java

Fish handling and identification

A total of 30 individuals consisted of 15 individuals of male and female *Pennahia anea* were examined during the study. Fresh individual fish samples were placed in cooler boxes to keep their morphological performances and colour. Upon arrival in the laboratory, the specimens were put in a freezer at -20°C until further examination. Trus morphometrics characters, standard and head length, were measured using a calliper with an accuracy of 0.005 cm. Truss morphometric measurements were conducted between 16 benchmark points and 31 truss distances (Figure 2). The truss distances were summarized in Table 1. The meristic characters were the number of gill rakers, the number of hard and soft rays on the dorsal, caudal, anal, ventral, and pectoral fins, the number of scales on the lateral line, the number of scale above the lateral line, and the number of scale under the lateral line. A total of 16 meristic characters were compared between male and female individuals (Sukmaningrum *et al*., 2020), with slight modification on the number of benchmark points and truss distances.

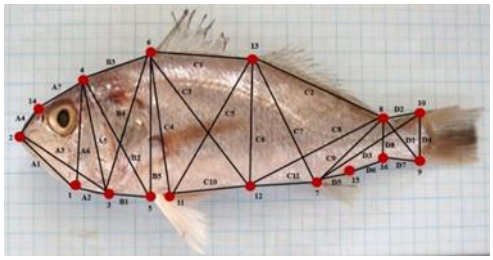

Figure 2. Truss Morphometric Characters Observed in Donkey Croaker (*Pennahia anea*)

Conventional identification was performed to ensure the taxonomic status of the samples. Identification was following the identification book from White et al. (2013), Carpenter and Niem (2001), and Saanin (1984). The validity of obtained scientific names was referred to the database available in FishBase (Froese and Pauly, 2021). Phylogenetic analysis was performed through phylogenetic tree or cladogram reconstruction. The cladogram was reconstructed based on 24 morphological characters, divided into three groups of characters; the ratio between two morphometrics measure, meristic, and general morphology performance. Morphometric characters refer to Ducic (2005). Detail characters used for phylogenetic analysis summarized in Table 1.

Data analysis

Data of truss distance and meristic characters, compared with the standard length, were analyzed using the "Mann-Whitney" test using SPSS software to distinguish male and female fish. The test was based on a 95% significance level or asymptote significance value of 0.05. The sexuality of the fish specimens was determined through dissection. Fish was dissected from the beginning anus to the anterior part of the stomach until to behind the operculum and dissected to the ventral part using surgical scissors. Dissection was performed carefully so as not to damage the internal organs, especially the gonads. The gonad topography was observed compared to the gonad topography of fish in Sukamto *et al.* (2010).

Results and Discussion

The total number of individuals fish samples used in this research was 53. The total length of fish samples ranges from 11.33 to 20.25 cm, while the weight ranges from 18.98 to 60.25 grams. According to Carpenter & Niem (2001), *P. anea* can grow up to 30 cm in length. According to Carpenter & Niem (2001) and White *et al*. (2013), Fish sample identification was conducted. It was proved that all the collected fish from TPI Asemdoyong belong to *P. anea*.

The morphological character of fish samples was fusiform with lateral line scales reaching the caudal fin's hind margin (Carpenter & Niem, 2001). The body colour was silvery grey, with the tip of the dorsal fin blackish. The observed colour is following White *et al*. (2013), who stated that *P. anea* has a fusiform body shape, with silvery grey body colour. According to Carpenter & Niem (2001), *P. anea* has a grey head and body. The abdomen is paler with silvery reflection.

The shape of the caudal fin is truncated (Figure 4.2. (a)). The type of scale is ctenoid (Figure 4.2. (b)), but there are cycloid scales on the head (Figure 4.2. (c)). The mouth position is terminal (Figure 4.2. (d)) and has small teeth on the lower jaw and large teeth without large fangs in the upper jaw (Figure 4.2. (e)). The observed characters follow Carpenter & Niem (2001) statement that *P. anea* has cycloid scales on its head, and in other parts, it has ctenoid scales. White *et al*. (2013) stated that this species has large upper teeth without large canines. Other morphological characters that distinguish *P. anea* from different species don't have a barbell and have two pairs of mental pores (Figure 4.2. e)). According to Carpenter & Niem (2001), these two pairs of mental pores are small. Based on Zhu *et al*. (1975), Sciaenidae generally has pores at the tip of the snout and lower jaw.

Table 1. Morphological characters used in phylogenetic analysis of pomacentrid fish.

Part	Body Part	No	Code	Annotation
A	Head	1	A1 (1-2)	The distance between the base points of the lower jaw and The tip of the snout
		2	A2 (1-3)	The distance between the base point of the lower jaw and The border between head and body (ventral part)
		3	A3 (2-3)	The distance between the tip of the snout and The border between head and body (ventral part)
		4	A4 (2-14)	The distance between the tip of the snout and The prominent part of the head
		5	A5 (3-4)	The distance between the border between head and body (ventral part) and The border between head and body (dorsal region)
		6	A6 (4-1)	The distance between the border between head and body (dorsal part) and The base point of the lower jaw
		7	A7 (4-14)	The distance between the border between head and body (dorsal part) and The prominent part of the head
B	Anterior Part of the Body	8	B1 (3-5)	The distance between the border between head and body (ventral part) and The front base of the ventral fin
		9	B2 (4-5)	The distance between the border between head and body (dorsal

Part	Body Part	No	Code	Annotation
				part) and The front base of the ventral fin
		10	B3 (4-6)	The distance between the border between head and body (dorsal part) and The front base of the 1st dorsal fin
		11	B4 (6-3)	The distance between the front base of the 1st dorsal fin and The border between head and body (ventral part)
		12	B5 (6-5)	The distance between the front base of the 1st dorsal fin and The front bottom of the ventral fin
C	Posterior Part of the Body	13	C1 (6-13)	The distance between the front base of the 1st dorsal find and The front bottom of the 2nd dorsal fin
		14	C2 (13-8)	The distance between the front base of the 2nd dorsal fin and The back base of the 2nd dorsal fin
		15	C3 (6-12)	The distance between the front base of the 1st dorsal fin and The midway between the ventral and anal fins
		16	C4 (6-11)	The distance between the front base of the 1st dorsal fin and The back base of the ventral fin
		17	C5 (11-13)	The distance between the back base of the ventral fin and The front bottom of the 2nd dorsal fin
		18	C6 (12-13)	The distance between the midway between the ventral and anal fin and The front base of the 2nd dorsal fin
		19	C7 (13-7)	The distance between the front base of the 2nd dorsal fin and The front bottom of the anal fin
		20	C8 (8-12)	The distance between the back base of the 2nd dorsal fin and The midway between the ventral and anal fin
		21	C9 (8-7)	The distance between the back base of the 2nd dorsal fin and The front bottom of the anal fin
		22	C10 (11-12)	The distance between the back base of the ventral fin and The midway between the ventral and anal fin
		23	C11 (12-7)	The distance between the midway between the ventral and anal fin and The front base of the anal fin
D	Cauda	24	D1 (7-9)	The distance between the front base of the anal fin and The ventral folds of the tail
		25	D2 (8-9)	The distance between the back base of the 2nd dorsal fin and The ventral folds of the tail
		26	D3 (8-10)	The distance between the back base of the 2nd dorsal fin and The dorsal folds of the tail
		27	D4 (10-7)	The distance between the dorsal folds of the tail and The front base of the anal fin
		28	D5 (10-9)	The distance between the dorsal folds of the tail and The ventral folds of the tail
		29	D6 (7-15)	The distance between the front base of the anal fin and The back base of the anal fin
		30	D7 (16-9)	The distance between the curved part of the tail (ventral aspect) and The ventral folds of the tail
		31	D8 (8-16)	The distance between the back base of the 2nd dorsal fin and The curved part of the tail (ventral aspect)

Observation of gonads in *P. anea* showed that male gonad was elongated, milky white, and a pair. The female gonad was elongated, yellowish to orange, and the number was a pair (Figure 3). Both male and female gonads are located under the swim bladder. The characters follow Burhanudin (2008) statement that the fish gonads are a pair, with the colour and size according to the level of maturity of the gonads. The gonads are elongated, located laterally or ventrally to the swim bladder. The male gonads (testes) are whitish, while the female gonads (ovaries) are reddish-yellow.

The results of measuring the ratio between the truss distance and the standard length and tested using the "Mann Whitney" are presented in Table 2. It is summarized in Table 2 there were 7 out of 31 characters that the Asymptote Significance value less than 0.05. It was clear that the ratio of the truss distance that distinguishes male and female *P. anea* are A1, A3, B4, C8, C9,

D3, and D5 (Figure 4). Based on Tuuli *et al*. (2011), *P. anea* is a gonochoric. Gonochoris is each individual has one genital (male or female). Tuuli *et al*. (2011) stated that the minimum size of gonad maturity for female *P. anea* was 125 mm in standard length, whereas, for males, it was 119 mm.

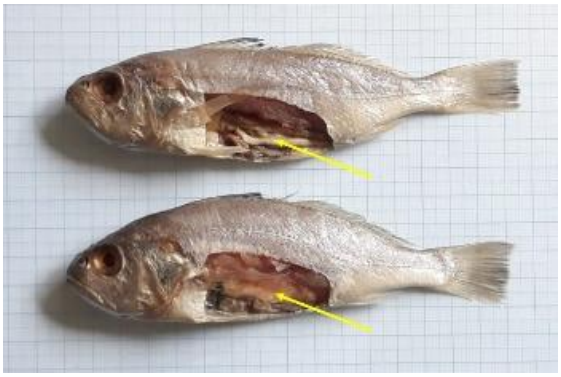

Figure 3. Gonad of *Pennahia anea* (a) Male Gonad; (b) Female

Table 2. The significance value of the Mann Whitney test of truss distance between male and female individuals

No	Truss	Mean Rank		Asymp. Sig	Mann Whitney Test
		M	F		
1	**A1**	**19,23**	**32,52**	**0,002**	*****
2	A2	26,95	27,03	0,986	NS
3	**A3**	**21,77**	**30,71**	**0,038**	*****
4	A4	30,45	24,55	0,170	NS
5	A5	24,41	28,84	0,304	NS
6	A6	26,14	27,61	0,732	NS
7	A7	29,36	25,32	0,348	NS
8	B1	27,59	26,58	0,814	NS
9	B2	24,82	28,55	0,386	NS
10	B3	22,59	30,13	0,080	NS
11	**B4**	**21,91**	**30,61**	**0,043**	*****
12	B5	24,73	28,61	0,367	NS
13	C1	26,50	27,35	0,843	NS
14	C2	31,68	23,68	0,063	NS
15	C3	25,14	28,32	0,459	NS
16	C4	24,73	28,61	0,367	NS
17	C5	26,00	27,71	0,691	NS
18	C6	25,73	27,90	0,613	NS
19	C7	25,18	28,29	0,470	NS
20	**C8**	**32,68**	**22,97**	**0,024**	*****
21	**C9**	**33,73**	**22,23**	**0,008**	*****
22	C10	25,50	28,06	0,551	NS
23	C11	27,64	26,55	0,800	NS
24	D1	26,05	27,68	0,705	NS
25	D2	25,23	28,26	0,481	NS
26	**D3**	**32,59**	**23,03**	**0,026**	*****
27	D4	26,55	27,32	0,857	NS
28	**D5**	**32,68**	**22,97**	**0,024**	*****
29	D6	30,09	24,81	0,220	NS
30	D7	26,50	27,35	0,843	NS
31	D8	24,91	28,48	0,406	NS

Note: M= male, F= female

The A1 character is the distance between the base points of the lower jaw and the tip of the snout. In male fish, the value was 19.23. In female fish, the value was 32.53. The A3 character is the distance between the tip of the snout and the ventral part of the border between head and body. In males, the value was 21.77. In female fish, the value was 30.71. The B4 character is the distance between the front base of the 1st dorsal fin and the ventral part of the border between head and body. In males, the value was 21.91. In female fish, the value was 30.61. It was observed that the male individual has a shorter distance than the female individual for those three truss characters.

In contrast, the male individual has a longer truss distance than the female individual for C8, C9, D3, and D5 truss characters. The C8 character is the distance between the back base of the 2nd dorsal fin and the midway between the ventral and anal fin. In males, the value was 32.68. In female fish, the value was 22.97. The C9 character is the distance between the back base of the 2nd dorsal fin and the front bottom of the anal fin. In males, the value was 33.73. In the female, the value was 22.23. The D3 character is the distance between the dorsal folds of the tail and the front base of the anal fin. In the male, the value was 32.59. In the female, the value was 23.03. The D5 is the distance between the front base of the anal fin and the back base of the anal fin. In males, the value was 32.68. In the female, the value was 22.97. From the results of data analysis, it was found that female *P. anea* has a longer anterior body, while male *P. anea* has a longer posterior body.

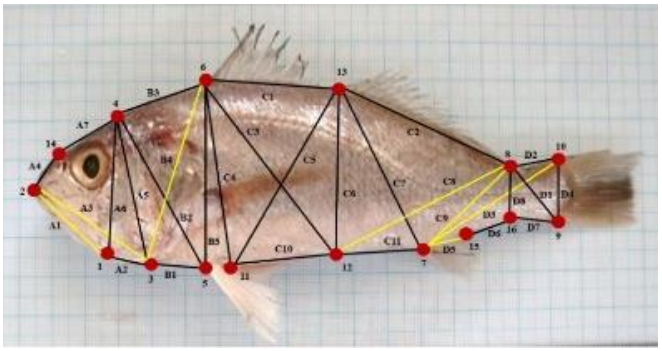

Figure 4. A significant difference in truss distance between male and female individuals. Note: The Yellow Line was Significant, and The Black Line was Non-Significant

A similar study by Sukmaningrum *et al*. (2020) found that the truss morphometric characters that differentiate male and female Oxeye Scad (*Selar boops*) were B1, B4, B9, D2, and D5. The B1 character is the ratio of the truss distance between the dorsal part of the border between head and body and the base of the anal fin. The B4 character is the ratio of the truss distance between the dorsal part of the border between head and body and the bottom of the anal fin. The B9 character is the truss distance between the front base of the 1st dorsal fin and the front base of the anal fin. The D2 character is the ratio of the truss distance between the back base of the anal fin and the dorsal fold of the tail. It was observed that the male individual has a shorter length than the female individual for those four characters. In contrast with the D5 character, the male individual has a longer distance than the female individual. The D5 character is the ratio of the truss distance between the ventral fold of the tail and the dorsal fold of the tail.

The result of the calculation of meristic characters is presented in Table 3 From these results, it is known that *P. anea* has fin formula D1.VIII-10; D2.I.22-25; C.17-20; A.II.7-8; V.I.4-5; P.14-17. The number of scales on the lateral line was 50 to 53. The number of scales above the lateral line was 6 to 8. The number of scales below the lateral line was 12 to 15. Carpenter & Niem (2001), *P. anea* has 9 to 10 hard fin rays on the 1st dorsal fin and one hard

ray on the 2nd dorsal fin with 22 to 24 soft rays. The anal fin has two hard rays and seven soft rays.

Table 3. The significance value of the Mann Whitney test of meristic character between male and female individuals

No	Meristic	Mean Rank		Asymp. Sig.	Whitney Test
		M	F		
1	D1H	23.73	29.32	0.141	NS
2	D1S	27.00	27.00	1.000	NS
3	D2H	27.00	27.00	1.000	NS
4	D2S	27.50	26.65	0.829	NS
5	CH	27.00	27.00	1.000	NS
6	CS	29.89	24.95	0.195	NS
7	AH	27.00	27.00	1.000	NS
8	AS	28.75	25.76	0.418	NS
9	VH	27.00	27.00	1.000	NS
10	**VS**	**29.50**	**25.23**	**0.050**	*****
11	PH	27.00	27.00	1.000	NS
12	PS	25.07	28.37	0.415	NS
13	SoLL	23.57	29.44	0.155	NS
14	SaLL	27	27	1.000	NS
15	SbLL	23.86	29.23	0.182	NS
16	GR	24.55	28.74	0.282	NS

Comparison to other fish species with similar body form (streamline) has been made and showed similar phenomena (Wijayanti et al., 2017; Sukmaningrum et al., 2020a; Sukmaningrum et al. 2020b; Suryaningsih et al., 2020). Wijayanti et al. (2017) proved that truss morphometric characters could differentiate male and female bigeye ilisha (*Ilisha megaloptera*). Similar result was also reported by Sukamaningrum et al. (2020a) in Splendid threadfin (*Philimanus perplexa* Feltes, 1991), Sukmaninfrum et al. (2020b) in selar bengol (*Selar boops*); and Suryaningsih et al. (2020) in silver barb Fish (*Barbonymus gonionotus* Bleeker, 1849). Based on present and those previous studies, it seem that truss morphometric is a reliable technique to differentiate male and female individuals of streamline body form fish although they do not show sexual dimorphisms.

Information on male and female individuals of *Pennahia anea* is vital for breeding program in domestication or mariculture development of this species. Information of male and female *Pennahia anea* is also essential for estimating population dynamic in natural populations which finally important for sustainable harvest of *Pennahia anea*.

Conclusion

Based on the result and discussion, it can be concluded that male and female individuals of *Pennahia anea* have different truss distances and meristic characters. Seven truss distances and one meristic character can distinguish male and female individuals of *Pennahia anea*. In the future studies, additional fish samples and truss distances are needed to improve the reliability of the method.

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