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Abstract. Silver barb (*Barbonymus gonionotus*) is one of the fish species with no sexual dimorphism. The study of sexual dimorphism in Silver barb with truss morphometric techniques has been limited. Truss morphometric is a recognized technique to distinguish male and female fish with no sexual dimorphism. Therefore, it was necessary to conduct a study which aimed to distinguish male and female using the truss morphometrics technique. The method was a survey in which fish samples were taken by purposive random sampling in the upstream, middle, and downstream areas of the River Klawing. The parameters were truss morphometrics distance and the total length of individual fish to calculate the ratio truss morphometrics distance of each fish sex. T-test was applied to compare the ratio truss morphometrics distance between males and females. The results showed that the truss morphometrics distance between males and females was characterized by the head, body, and tail. In general, male fish have a more elongated body size than female fish.

1. Introduction

Silver barb is a pond or open-water freshwater fish that has important economic value.[1] The fish usually are marketed fresh and occasionally seen in the aquarium trade. They inhabit mid- to bottom-depth of rivers, streams, floodplains, and sometimes reservoirs. They seem to prefer standing water instead of flowing water habitats. Silver barbs also inhabit the flooded forest during a high water period and feed on plant matter (e.g., leaves, weeds, *Ipomea reptans,* and *Hydrilla*) [2].

Silver barb belongs to the genus Barbonymus in Cyprinidae, Cypriniformes, and Actinopterygii (ray-finned fishes) [2]. The morphological character of silver barb includes total dorsal spines (4), total dorsal soft rays (8), anal spines (3), anal soft rays (6-7). The body is strongly compressed. The back is elevated with its arched dorsal profile, often concave above the occiput. The head is small with a pointed snout, and terminal mouth. The barbels are very minute or rudimentary, especially the upper ones, which sometimes disappear entirely. The individuals are silvery-white, sometimes with a golden tint. The dorsal and caudal fins are gray to gray-yellow; the pectoral fins pale to light yellow. Very few tubercles on the snout which are not visible without magnification; snout length much less than the width of the eye socket. Anal-fin with 6-7 branched rays [2].

Silver barbs are easily maintained in various types of media and do not require specific land, neither require much capital, and easily bred. Silver barb is herbivore but has been bred and given food pellets or natural food of Colocasia leaves [3].

In order to support conservation efforts and increase the success of silver barb spawning, basic biological information is needed from various aspects, including taxonomic characters. The characters include morphological, physiological, reproductive, ecological, geographic, genetic characters [4]

Morphometric characters are part of morphological characters that analyze quantitative measurements, including organism size and shape [5]. There are two methods for studying morphometric characters, standard morphometric and morphometrics truss technique. The truss morphometric technique is a technique by which truss distance measurements of morphometrics are carried out on the outside of a particular body. The measurements can be used to distinguish sex based on morphological characters with reasonably accurate results. Truss morphometric distance is based on morphometric truss points that can be determined as many as possible. If the morphometric truss points are interconnected, then truss morphometric distance will be formed horizontally, vertically, and diagonally. Thus, a more detailed and specific body image will be obtained compared to the standard morphometry technique. The basis of the truss morphometric method is that male and female fish have different growth patterns. Thus, when they are analyzed in detail, different body parts or truss distances are obtained [6]. Truss morphometric technique can identify possible morphological differences in organisms of a close relationship between species and within species. This technique is more recommended, compared to standard morphometry technique where the truss distance is minimal, so it is unable to distinguish the organism morphology [7].

The truss morphometric technique has been able to identify differences in male-female morphologically on various species of fish which generally have less or no apparent sexual dimorphism, such as red cheek barb [8], hampala fish [9], kemprit fish (*Ilisha megaloptera* Swainson, 1839) 10], and in snakes skin gourami Information about sexing in silver barb is essential because, in this species, sexual dimorphism is not apparent [11][12]. Information about individual sexing is beneficial for conservation efforts, including rationalizing fishing in public waters and spawning efforts. The prospective broodstock that correctly identified allows the increased success of spawning [8]. This study aimed to distinguish male and female silver barb morphometrically, and to understand the distance between truss morphometrics useful for sex differentiating character.

2. Methods

2.1 Sampling Site and Fish Collection

The study was carried out for four months, starting from June to September 2016. The survey method was conducted by taking simple random sampling techniques. The sampling site represents three areas, the River Klawing upstream, middle stream, and downstream. The fish were preserved with 4% formalin, then identified and determined using a blend of freshwater fishes of Western Indonesia and Sulawesi [11].

2.2 Measurement of morphometric characters

The measurement of morphometric characters using the truss morphometric technique is as follows. The silver barb was placed on waterproof paper, with the head position on the left, then the length and weight measurement were taken. In each fish, 11 truss morphometrics were determined based on Mojekwu and Anumudu [6] with modifications. Measurements were made using a caliper (0.01 mm accuracy) then the fish was placed in a tub of coated preparations in succession with waterproof paper, blank paper, and styrofoam. The truss points were marked by plugging the needle into the styrofoam. A measurement of 24 truss distances was carried out by connecting the points. The measurement results for all truss distances were compared to the total length, resulting in a truss distance ratio. After the measurement was complete, surgery was performed to determine the sex, to match the measurement results of each fish. The location of points and distance of truss is presented in Figure 1 and the truss description is provided in Table 1.

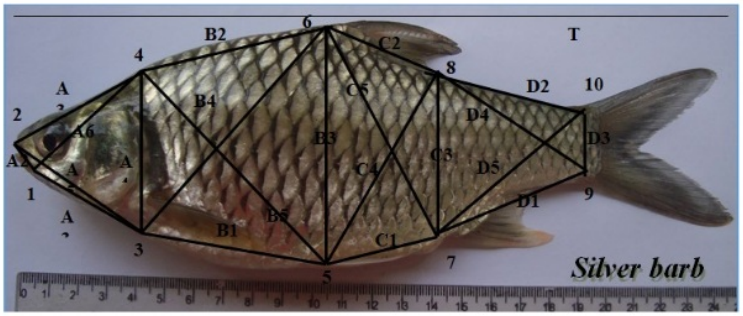

Figure 1. Location of points and truss morphometric distance of the observed silver barb

Table 1. Description of the truss morphometrics distance

Truss character	Code of truss distance	Code of truss distance ratio	Description of the truss morphometrics distance
Head	A1	A1'	The base of lower jaw - border of head and ventral body
	A2	A2'	The base of the lower jaw - the front end of the muzzle
	A3	A3'	The tip of the snout - the head and dorsal body boundary
	A4	A4'	The boundaries of the head and dorsal body-the boundaries of the head and ventral body
	A5	A5'	The tip of the snout - the boundaries of the head and ventral body
	A6	A6'	The boundaries of the head and dorsal body-based of mandibular body
Anterior body	B1	B1'	The boundaries of the head and ventral body - front of pelvic fin
	B2	B2'	The boundaries of the head and dorsal body - the front of the dorsal fin
	B3	B3'	The front base of the dorsal fin - the front of the pelvic fin
	B4	B4'	The boundaries of the head and dorsal body - the front of the pelvic fin
	B5	B5'	The front base of the dorsal fin – the boundaries of the head and ventral body
Posterior body	C1	C1'	The front of the pelvic fin - the front of the anal fin
	C2	C2'	The front base of the dorsal fin - the back base of the dorsal fin
	C3	C3'	The back of the dorsal fin - the front base of the anal fin
	C4	C4'	The front base of the dorsal fin - the front of the anal fin
	C5	C5'	The back base of the dorsal fin - the front of the pelvic fin
Tail	D1	D1'	The front of the anal fin - folding of the ventral tail
	D2	D2'	The back base of the dorsal fin-folds the dorsal tail
	D3	D3'	Folding of the dorsal tail - folding of the ventral tail
	D4	D4'	The back of the dorsal fin - folding of the ventral tail
	D5	D5'	The front base of the anal-fold fin of the dorsal tail

2.3 Data analysis

The measurement data of truss distance were compared to the total length so that the truss distance ratio was obtained. Then T-test was performed between male and female fish groups. It was expected that there a truss morphometrics ratio from a significant truss distance between male and female fish, which can help distinguish the sex of silver barb fish.

3. Results

The results of measuring the ratio of truss distance to the total length and the 't' test between male-female barb silver are presented in Table 2 and Figure 2.

Table 2. Average of truss distance ratio and 't' test in silver barb (n male = 183 n, female= 200)

No.	Code of truss distance	Code of truss distance ratio	Average of truss distance ratio ± deviation standard		't' test
			Male	Female	
1.	A1	A1'	0,121±0,013	0,121±0,011	ns
2.	A2	A2'	0,062±0,007	0,061±0,003	ns
3.	A3	A3'	0,118±0,007	0,105±0,004	**
4.	A4	A4'	0,145±0,004	0,154±0,005	**
5.	A5	A5'	0,125±0,007	0,125±0,006	ns
6.	A6	A6'	0,118±0,008	0,119±0,007	ns
7.	B1	B1'	0,223±0,010	0,235±0,006	**
8.	B2	B2'	0,277±0,028	0,277±0,012	ns
9.	B3	B3'	0,317±0,017	0,325±0,016	**
10.	B4	B4'	0,310±0,015	0,331±0,017	ns
11.	B5	B5'	0,352±0,034	0,348±0,021	ns
12.	C1	C1'	0,209±0,016	0,223±0,004	**
13.	C2	C2'	0,137±0,010	0,137±0,006	ns
14.	C3	C3'	0,253±0,012	0,258±0,011	**
15.	C4	C4'	0,316±0,033	0,314±0,018	ns
16.	C5	C5'	0,307±0,033	0,304±0,019	ns
17.	D1	D1'	0,183±0,017	0,168±0,011	**
18.	D2	D2'	0,223±0,012	0,204±0,007	**
19.	D3	D3'	0,129±0,081	0,128±0,028	ns
20.	D4	D4'	0,284±0,022	0,282±0,010	ns
21.	D5	D5'	0,267±0,019	0,265±0,009	ns

Remarks of the truss morphometrics distance and distance ratio of Table 2.
ns=non significant **= highly significant

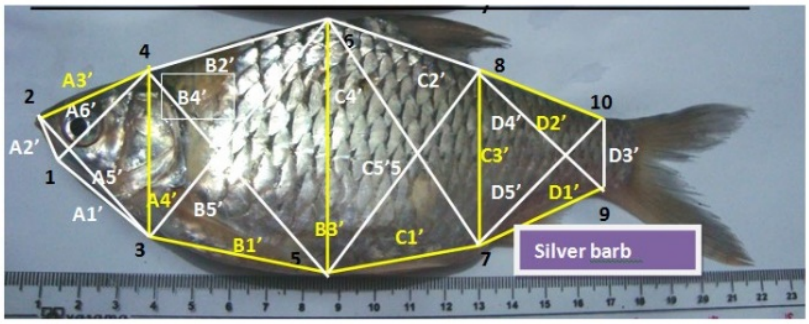

Figure 2. Location of the truss morphometrics distance between male and female silver barb: highly significant (yellow line) and nonsignificant (white line).

Based on Table 2. it can be seen that there are 8 out of 21 ratios of truss distances that are very significantly different between male and female silver barb, which is found in the head, body, and tail. In the head area, there are two very significant different truss distance ratios, namely A3' and A4'. A3', which is the ratio of the truss distance between the tip of the snout and the boundary between the dorsal heads and the total length, the value for females is 0.105 ± 0.005, smaller than the male fish of 0.118 ± 0.007 (P <0.01). Furthermore, A4', which is the ratio of truss distance between the head-body boundary to the dorsal boundary of ventral bodies with total length, the value for females is 0.154 ± 0.005, higher than that of male fish which is 0.145 ± 0.004 (P <0, 01). Head height is a distance that is

visually easily recognizable so that it can be used as a guide for individual sexing. In general, female silver barb head is higher than male fish.

4. Discussion

The ratio of the distance to the next truss, which is very significantly different in the anterior body area of the silver barb, namely B1' and B3'. B1' is the truss distance between the head and ventral-front body of the pelvic fin with total length. B1' truss distance ratio in female silver barb is 0.235 ± 0.006, which is higher than that of males, which is 0.223 ± 0.010 (P <0.01). B1 is a visually recognizable distance so that it can be applied as a guideline for individual sexing, that female silver barb generally has an anterior belly larger than male fish. B3', is the ratio of truss distance between the base front of the dorsal fin and the front of the pelvic fin (height) with total length. The B3 truss distance ratio for female red cheek barb fish is 0.325 ± 0.016, which is higher than that of male fish, which is 0.317 ± 0.017 (P <0.01). B3 is a visually easily recognizable distance so that it can be applied as a guideline for individual sexing, female silver barb are generally taller than male fish.) This is different from the condition in red cheek barb fish, in silver barb, whose B4 value of female fish is smaller than B4 male fish as fellow Cyprinid fish, which is very close to their relationship [8], [13]. Our result showed that the truss morphometrics pattern between red cheek barb and silver barb is different in the anterior body.

The truss distance ratio is very different in the posterior area of the body, namely C1' and C3', as well as in red cheek barb. C1 is the truss distance between the base front of the pelvic fin - the front of the anal fin (the place where the egg is in the posterior part) with total length. The C1' truss distance ratio on female red cheek barb is 0.223 ± 0.004, higher than that of males, which is 0.209 ± 0.016 (P <0.01). C1 is a visually recognizable distance so that it can be applied as a guideline for individual sexing, that the posterior abdomen of female silver barb is generally larger than male fish. C3' is the ratio of truss distance between the back base of the front dorsal fin of the anal fin (posterior body height) with total length. The C3' truss distance ratio on female red cheek barb is 0.258 ± 0.011, which is higher than that of males, which is 0.253 ± 0.012 (P <0.01). C3 is also an easily recognizable distance so that it can be applied as a guideline for individual sexing, that the posterior body of female silver barb is generally higher than male fish. In silver barb, the truss distance ratio is very different in the rear body area.

The truss distance ratio is very different in the tail area, namely D1' and D2'. D1' is the ratio of the truss distance between the base front of the anal fin-fold of the ventral tail and the total length. The D1' truss distance ratio for female red cheek barb is 0.168 ± 0.011, which is smaller than that of males, which is 0.183 ± 0.017 (P <0.01). D2' is the ratio of the truss distance between the back base of the dorsal fin-fold of the dorsal section and the total length. The D2' truss distance ratio in female brackets is 0.204 ± 0.007, smaller than that of males, which is 0.223 ± 0.012 (P <0.01). D1 and D2 are easily recognizable distances, so they can be applied as guidelines for sexing. In silver barb, the ratio of truss distance is very different in the tail area of the pattern, not the same as red cheek barb fish, as fellow Cyprinids are very close to their relationship [8],[14]. The result shows that the difference in morphometrics truss pattern between red cheek barb and silver barb is in the tail.

5. Conclusion

The male and female individuals of silver barb fish can be distinguished based on truss morphometric techniques. The truss morphometric distance ratio, which is a distinctive character, is 8 out of 21 ratios of truss morphometrics compared to the head, body, and tail. The male fish has a lower-body height and height of the tail with a slimmer appearance. In general, male fish have a more elongated body size than female fish.

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