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Morphology and Anatomy of Endemic Fish *Leptobarbus melanopterus* (*Cyprinidae*) in Danau Sentarum National Park Kapuas Hulu Regency

Ari Hepi Yanti, Tri Rima Setyawati*, Barrata

Department of Biology, Faculty of Mathematics and Natural Sciences, Tanjungpura University, Pontianak, Indonesia

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ABSTRACT

One of the endemic freshwater fishes in Danau Sentarum National Park (DSNP) is *Leptobarbus melanopterus* which has high economic value for both commercial and collection purpose. However, the overfishing of *L. melanopterus* running over decades with harmful catch tools is worried could contribute to the population decline in the future. At the same time, this species has never been cultured and fishermen catch directly in the habitat on a daily basis. This research was aimed to identify the morphological and anatomical characters of *L. melanopterus*. All samples were collected from three different sites in DSNP and measured its morphological and anatomical sizes manually. The results showed that the length of mandibula barbel was the distinguishing character between females and males, with loading score of 0.81. Most meristic variables showed no difference between two sexes. In terms of anatomical measurements, *L. melanopterus* females had larger gill sizes than males, including gill raker, gill arch and fill filament. Our findings signify the thorough morphological and anatomical sizes of *L. melanopterus* which are important in identifying fish stock, growth pattern and sexual dimorphism for future culture management.

1. Introduction

The biodiversity of aquatic fauna in Indonesia varies greatly, specifically about 900 freshwater fish species can be found in the western part of Indonesia and Sulawesi (Kottelat *et al.* 1993). One of the conservation sites in the western part of Indonesia with diverse freshwater fish is Danau Sentarum National Park (DSNP), located in West Kalimantan. DSNP is well-known as a vast floodplain ecosystem in Indonesia of 132,000 hectares which has become a habitat for a wide range of freshwater fish species, up to 210 species (Kottelat *et al.* 1993; Widjanarti 1996).

Not only non-endemic fishes live here, there are some endemic fish species and one of them is Leptobarbus melanopterus (or known by local people as peam fish (Roberts 1989). *L. melanopterus* has unique morphology characteristics, such as bright red blotch on the operculum, red and black caudal fin and blackish silver body, that attract many fish collectors. This species is also often consumed by local people or sold in markets as fresh fish or salted fish because of its high economic value. We have interviewed some fishermen living in DSNP that according to them *L. melanopterus* has tasty flavor so that attracts local people to buy it with the current market price range is Rp. 20,000-25,000 per kg (approximately equals to $1.47-1.83).

Looking at the economic potential of *L. melanopterus*, most of the local fishermen still rely heavily on catch from the natural habitat by using different types of catch tool, such as traps and nets, which are considerable in size with small-meshed nets. These two catch tools do not only trap adult fish but also juvenile ones that might harm the existence of *L. melanopterus* population in the habitat, leading to a decline in the near future especially without having any information about its biological characteristics for culture management.

Differs from *L. melanopterus*, a local species from the same genus called *L. hoevenii* has been cultured successfully and its morphology have been known. According to Fishbase (2018), this species has a percentage of body depth of 29.1%, head length of 18.3% and predorsal length of 40.8% of total length. By contrast, the scientific study about *L. melanopterus* characteristics related to the difference in morphology

* Corresponding Author
E-mail Address: tri.rima.setyawati@fmipa.untan.ac.id

(morphometric and meristic) and anatomy is still unassessed.

This present study aimed to examine morphological and anatomical differences of *L. melanopterus* as it is required to identify fish stocks and growth pattern as part of aquaculture. Analysis of the morphological and anatomical characters can be the reference for identification that have not been described comprehensively (Roberts 1989).

2. Materials and Methods

2.1. Sample Collection

A total of 64 *L. melanopterus* consisting of 32 males and 32 females were sampled through purposive sampling method using traps, fish rod and gill net. The study occurred in May to July 2018 in three sites namely site 1 at Luar Lake (0°54'19.11"U, 112°12'51.25"T), site 2 at Genali Lake (0°51'15.12"U, 112°8'11.26"T), and site 3 near Tekenang Hill (0°51'18.66"U, 112°4'36.66"T). As many as 21 morphological measurements were applied in each sample (Figure 1), along with some measurements of meristic (Figure 2) and internal organs with Mitutoyo calliper. The measured internal organs consist of nine characters including esophagus (ESO), stomach (LAM), intestine (USUS), swim bladder (GEL. R), heart (JTG), liver (HATI), gill raker (GILL. R), gill filament (GILL. F) and gill arch (GILL. A). Samples from each sex were divided into groups based on its total length ranges by calculating the number of class (n) and class width (C). The number of class (n) was obtained from the calculation with total sample (N), while class width (C) was obtained from maximum total length (a), minimum total length (b) and the number of class (n). The formula can be seen below:

$$n = 1 + 3.32 \log N \qquad C = \frac{a - b}{n} \qquad \text{(Walpole 1982)}$$

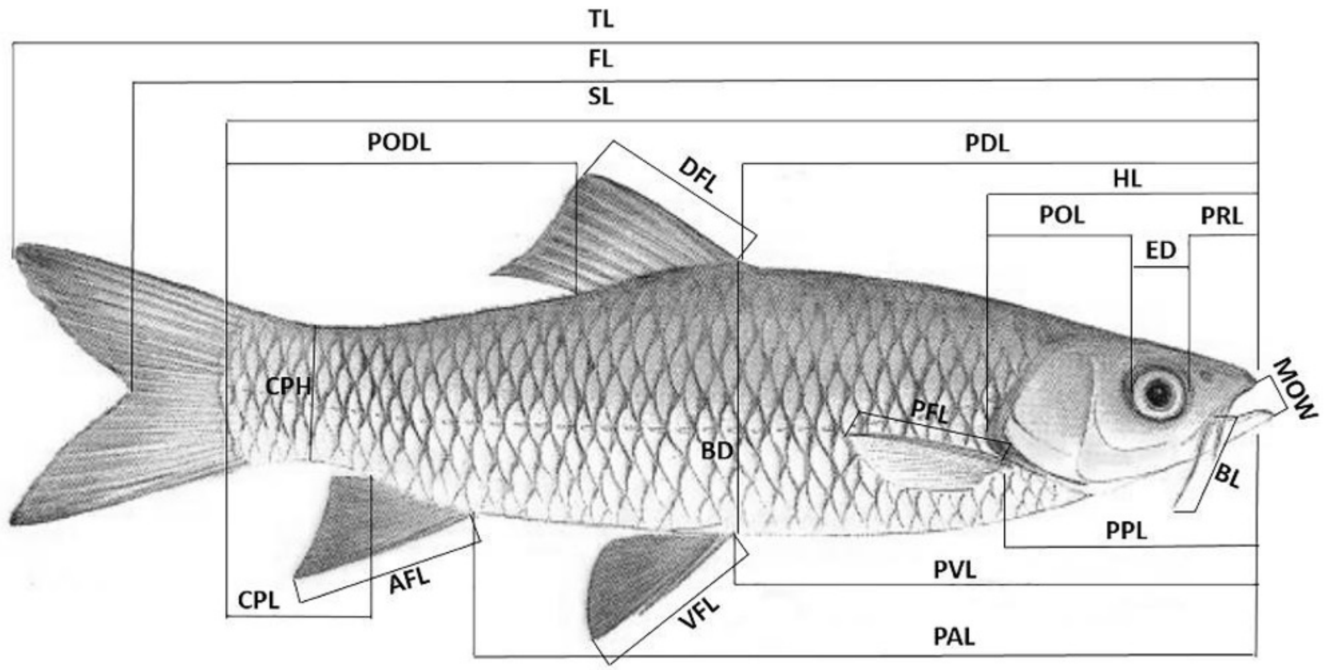

Figure 1. Morphometric measurements. TL: total length, SL: standard length, FL: fork length, PDL: pre dorsal length, PODL: post dorsal length, PPL: pre pectoral length, PVL: pre ventral length, PAL: pre anal length, PRL: pre orbital length, POL: post orbital length, HL: head length, ED: eye diameter, BD: body depth, CPL: caudal peduncle length, CPH: caudal peduncle height, DFL: dorsal fin length, PFL: pectoral fin length, AFL: anal fin length, VFL: ventral fin length, MOW: mouth opening width, BL: barbel length

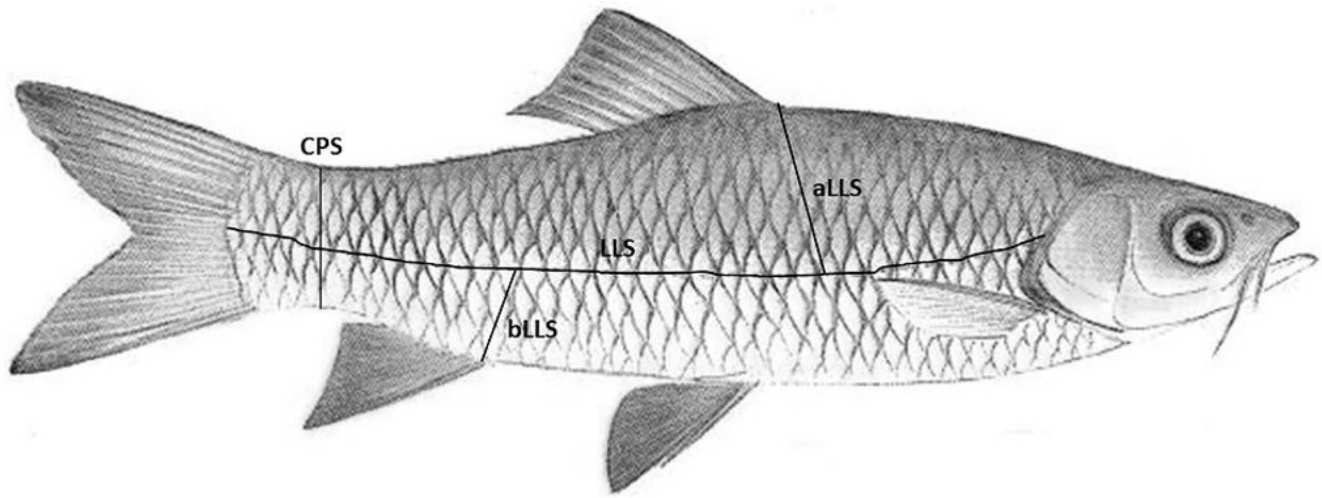

Figure 2. Meristic characters. LLS: lateral line scales, aLLS: above lateral line scales, bLLS: below lateral line scales, CPS: caudal peduncle scales

2.2. Principal Component Analysis (PCA)

The morphometric measurements were analyzed using PAST and, to minimize dissimilarity, all variables were adjusted using an allometric approach as proposed by Elliott *et al.* (1995). PCA was used to simplify data by showing the main components and exploring diversity patterns in body parts. The results of PCA is a data matrix which its value shows the relationship between each character. A minus or positive sign indicates a negative or positive correlation between parameters (Muhotimah *et al.* 2013). The standardized measurement is calculated as follows:

$$Madj = M\left(\frac{Ls}{L0}\right)^b$$

Where:
Madj = the standardized measurement
M = the original measurement
Ls = the overall mean of standard length for all samples
L0 = the standard length
b = the regression slope of log M on log L0 of fish from each group

3. Results

3.1. Morphological Measurements of *L. melanopterus*

Each sex group of *L. melanopterus* was classified into six classes based on the total length (Table 1). The PC analysis of morphological and anatomical characters of *L. melanopterus* produced some Principal Components (PCs) and eigenvalues. The main components of PCA results were chosen based on eigenvalue >1, variant percentage and scree plot. The interpretation of PCA results focused on the loading scores that greater than 0.5 (very significant).

The PCA analysis of 24 PC morphometric measurements yielded three principal components explaining 66.68% of the total variance (37.10% of PC1, 22.16% of PC2 and 7.42% of PC3) in the entire dataset, with eigenvalues of 8.9, 5.32 and 1.78, respectively. The main characters in PC1 are VFL (0.94), BD (0.92), SL (0.89), AFL (0.89), CPH (0.84), DFL (0.83), IL (0.82), and BL MAN (0.81). PC2 consisted of three main characters, namely TL (0.88), PVL (0.86), and PDL (0.80), while PC 3 only had one main character that was MOW (0.64). The biplot of morphometric analysis showed that there were some data from female groups located farther than male groups, such as KL 01, KL 02, KL 03, and KL 28. Also, there were several characters grouping on PC1 negative area (PVL, PPL, PDL, PAL, and ED). These characters were located to

Table 1. Total length group of *L. melanopterus* male and female

Sex	Total length group (K) (mm)	Body weight (gram)	Total samples
Male	K1 (146-163)	40-60	23
	K2 (164-181)	50-70	4
	K3 (182-199)	50	2
	K4 (200-217)	-	-
	K5 (218-234)	-	-
	K6 (235-252)	110-170	3
Female	K1 (141-167)	40-70	22
	K2 (168-194)	40-60	5
	K3 (195-221)	-	-
	K4 (222-248)	110-130	3
	K5 (249-275)	-	-
	K6 (276-302)	280-350	2

the distribution of data in II and III quadrants (Figure 3).

The results of *L. melanopterus* morphometric measurements are also represented as a percentage. This percentage is obtained from the average value of each character of all *L. melanopterus* samples (Table 2). No significant difference between males and females is found from the calculation results. The ratio of each character can be seen in Table 3.

The meristic variables were analyzed based on the body shape, the structure and the number of certain countable organs. *L. melanopterus* body shape was fusiform with an overall body color of black and silver, the dorsal section was black, while the ventral portion is silver (Figure 4). *L. melanopterus* had complete fins in dark red colored, especially the red color of caudal fin was located on the outer edge of the tail lobe and had deeply forked caudal fin (Figure 5). Each body side had continuous and

Table 2. Average morphometric size of *L. melanopterus* female and male

Character	Averange	
	Male	Female
Total length (TL)	166.96	170.56
Standard length (SL)	128.82	128.21
Body depth (BD)	36.17	36.34
Pre dorsal length (PDL)	64.33	64.64
Pre pectoral length (PPL)	32.95	34.05
Head width (HW)	17.61	18.23
Head length (HL)	34.44	35.31
Eye diameter (ED)	7.52	7.67

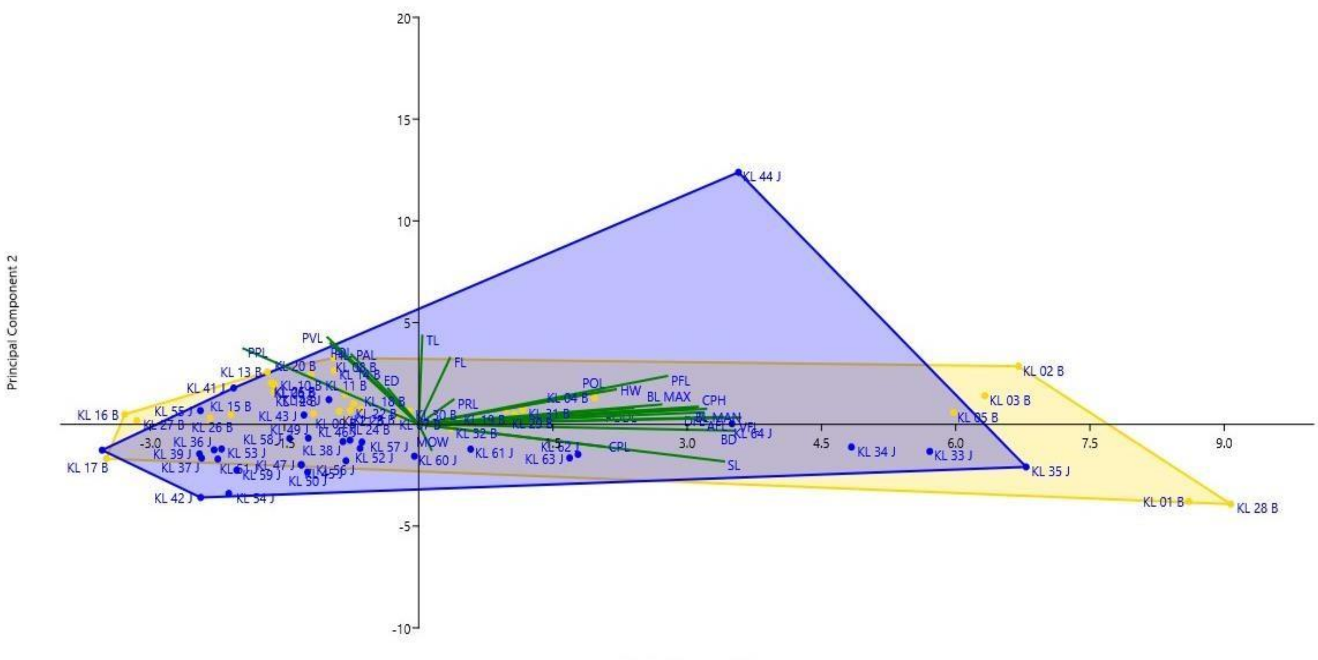

Figure 3. The PCA biplot of morphometric analysis. Blue: male, yellow: female

Table 3. Morphometric character ratio of *L. melanopterus* female and male

Character	Percentage (%)	
	Male	Female
Head length (HL): total length (TL)	20.63	20.70
Body depth (BD): total length (TL)	21.66	21.31
Pre dorsal length (PDL): total length (TL)	38.53	37.90
Standard length (SL): total length (TL)	74.76	75.17
Eye diameter (ED): head length (HL)	21.84	21.72
Head width (HW): head length (HL)	51.13	51.63
Pre pectoral length (PPL): pre dorsal length (PDL)	51.22	52.68

slightly downward lateral line behind the operculum. Other morphological characteristics were such red spots on the operculum as the most distinct feature of this species. Meanwhile, the head part was colored in black on the dorsal and grey on the ventral (Figure 6). *L. melanopterus* mouth was located terminally and had a protrusible mouth which can be extended while capturing preys. There were two pairs of barbel, namely maxilla and mandible, the teeth were villiform and three pairs of branchiostegal.

Figure 4. *L. melanopterus* body. Above-male, below-female

3.2. Anatomical Measurements of *L. melanopterus*

The morphology of internal organs of both sexes can bee seen on Figure 7. The swim bladder of *L. melanopterus* was categorized as the physostome type or had a pneumatic duct that connects swim bladder with the digestive tract

The swim bladder of *L. melanopterus* was categorized as the physostome type or had a pneumatic duct that connects swim bladder with the digestive tract. The swim bladder length range was 38.00-92.81 mm and the heart length range was 2.50-13.30 mm (Figure 8). Gills consisted of three parts which were gill arch, gill filament and 16 gill rakers (Figure 9). The gill arch length range was 11.16-34.12 mm, gill filament ranged from 3.00 to 10.33 mm and gill raker ranged from 0.10 to 3.00 mm. The

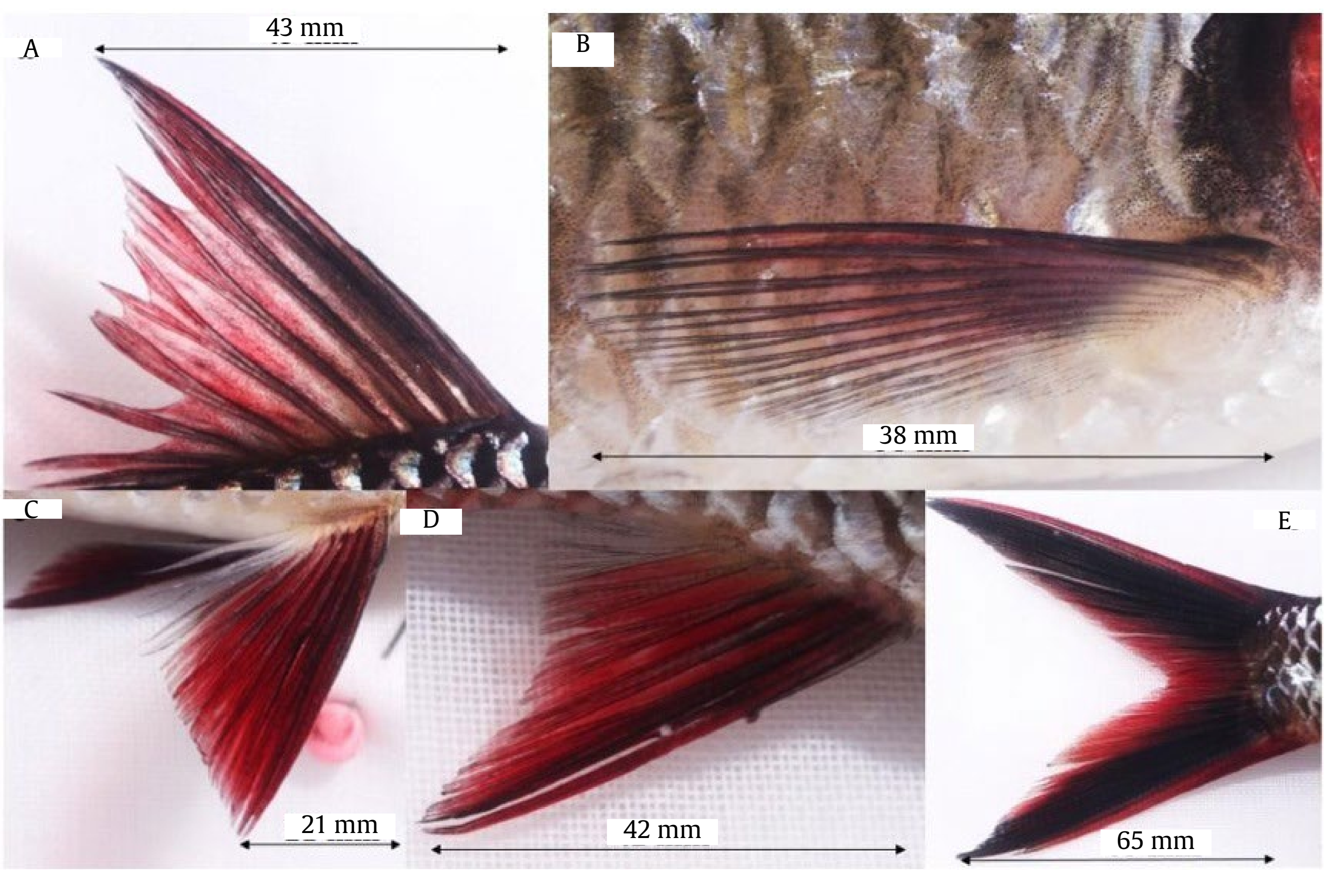

Figure 5. *L. melanopterus* fins. (A) dorsal fin, (B) pectoral fin, (C) ventral fin, (D) anal fin, (E) caudal fin

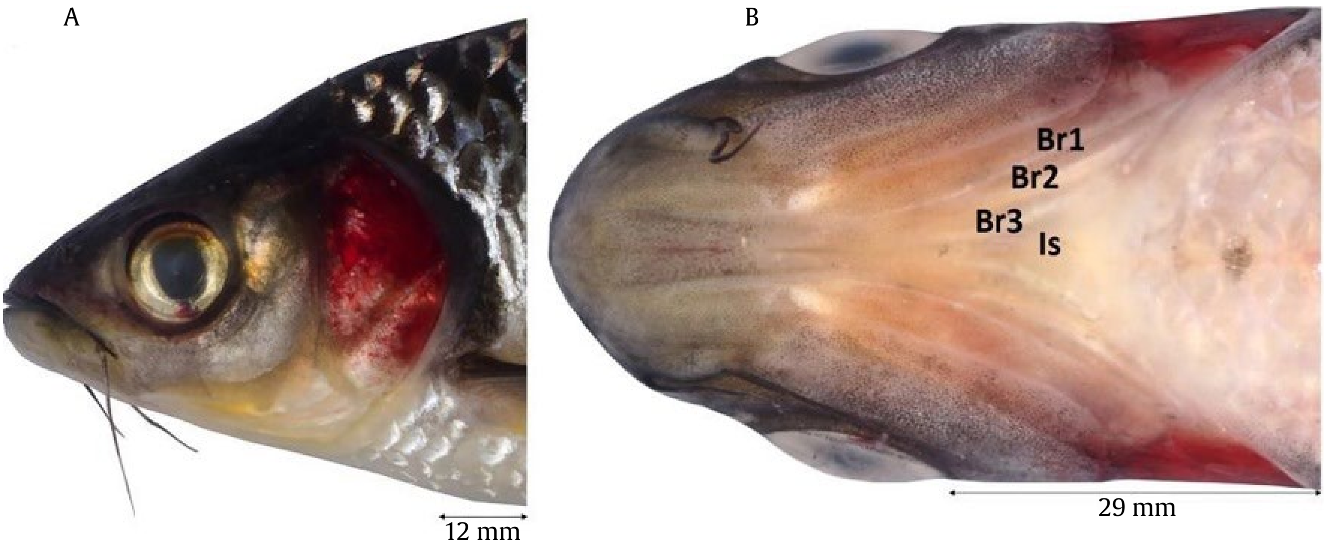

Figure 6. The head of *L. melanopterus*. (A) head from side view, (B) branchiostegal (Br 1-3), Is-*isthmus*

Figure 7. The internal organ photographs of *L. melanopterus*. Above-female, below-male

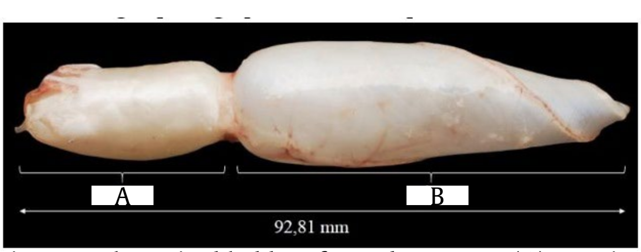

Figure 8. The swim bladder of *L. melanopterus*. (A) anterior chamber, (B) posterior chamber

liver length also had a range of 30.81-196.00 mm (Figure 10).

The anatomical measurements were examined to obtain any distinguishing anatomical characteristic of males and females with PCA. The PC analysis produced three principal components explaining 68.70% of the total variance (41.13% of PC1, 16.16% of PC2, and 11.4% of PC3). PC1 consisted of five main characters namely intestine (USUS) (0.85), stomach (LAM) (0.83), gill arch (GILL. A) (0.77), gill filament (GILL. F) (0.71), and gill raker (GILL. R) (0.68). The main characters on PC2 were esophagus (ESO) (0.77), whereas on PC3 was heart (JTG) (0.76). All of these characters located at the positive area in both I and IV quadrants. Most of the male and female data lied on the negative PC (II and III quadrants). The biplot of anatomical analysis can be seen in Figure 11.

4. Discussion

4.1 Morphometric Variation of *L. melanopterus*

The PC analysis of *L. melanopterus* morphometric measurements were carried out in a combined group of male and female individuals, aiming to see difference in terms of morphology in males and females. Based on the morphometric biplot, there

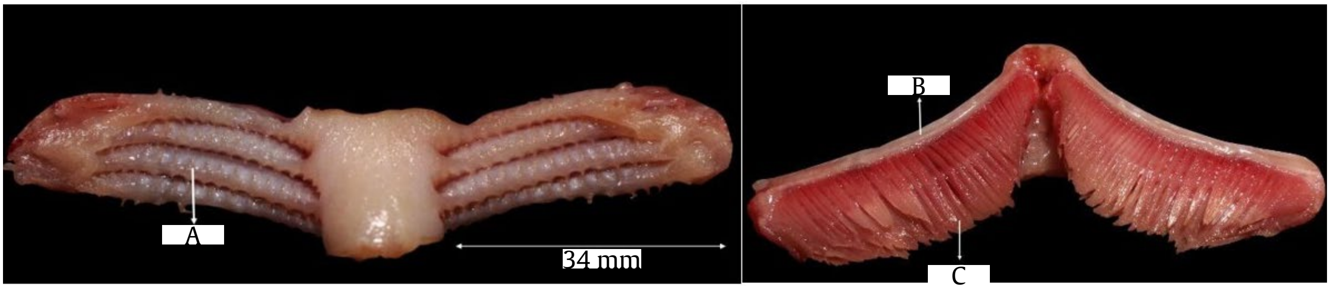

Figure 9. The gill of *L. melanopterus*. Left: behind view, right: front view, (A) gill raker, (B) gill arch, (C) gill filament

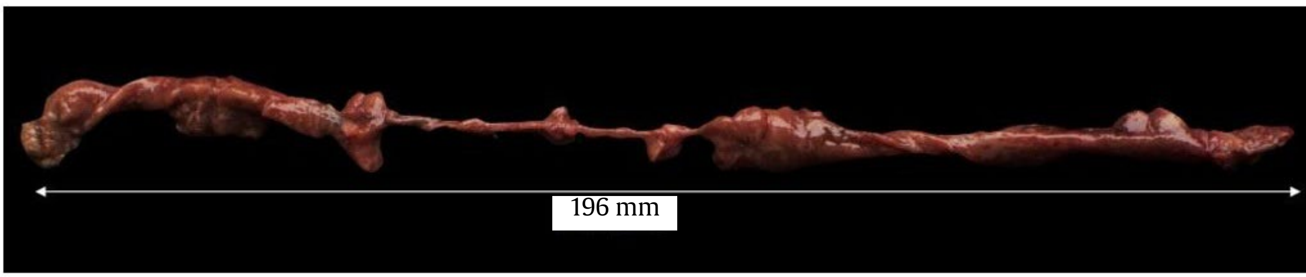

Figure 10. The liver of *L. melanopterus*

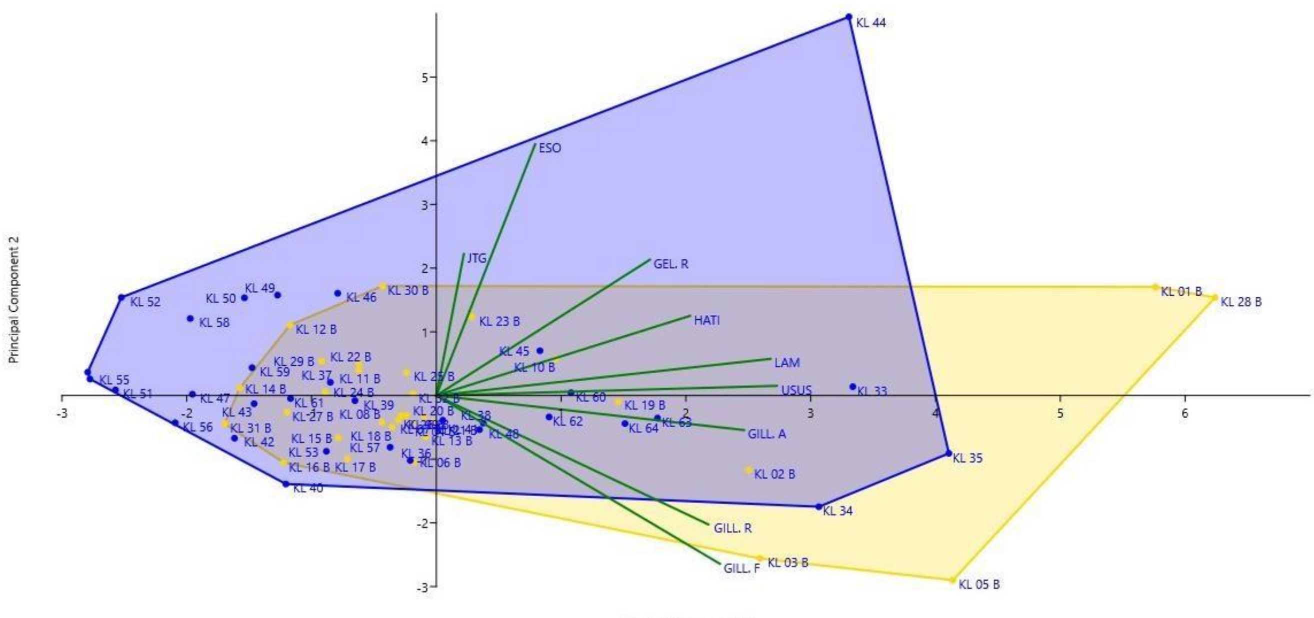

Figure 11. The PCA biplot of anatomical measurements of *L. melanopterus*. Blue: male, yellow: female

were eight main characters: VFL, BD, SL, AFL, CPH, DFL, IL, and BL MAN. These eight characters lead to the distribution of the adult male data (KL 33, KL 34, KL 35, KL 61, KL 62, KL 63, and KL 64) and the adult female data (KL 01, KL 02, KL 03, KL 04, KL 05, KL 19, KL 28, KL 29, KL 31, and KL 32) that located on I and IV quadrants. Based on those characters, it can be interpreted that the main morphological characters to distinguish between *L. melanopterus* adult and juvenile groups were those at the opposite side (II and III quadrants). The data distribution of juvenile group consists of K1 male (146-163 mm) and K1 female (141-167 mm). Based on the eight characters, it can be divided into four categories: fin (VFL, AFL, and DFL), body size (BD and SL), sensory organs (IL and BL MAN) and tail (CPH).

One of the main morphometric characters in the fin category is VFL. The VFL of *L. melanopterus* adults are larger than juveniles which might indicate certain behavior patterns during mating season. Larger VFL of *L. melanopterus* male and female adults may have a special advantage, for example, larger VFL size in males help them to dig water substrate as a place for females to lay the eggs, while in females it helps in the egg-laying process in large quantities (Raagam and Devi 2005). Therefore, the VFL size in *L. melanopterus* adults signify typical behaviour during the mating season.

The size of BD also correlates with median fin sizes such as DFL and AFL. According to Wanek and Sturmbauer (2015), BD size can affect the variation of fish body shape. The body shape will be streamlined and shaped compressed if BD size is narrow, while for wider BD will result in a deep-bodied shape. The streamlined body tends to have shorter DFL and AFL than deep-bodied fish, such as *Cichlidae. Cichlidae* is a deep-bodied fish group which tends to live in the littoral area with more complex environmental structures (Feilich 2016), while *L. melanopterus* is more active in the pelagic zone. Therefore, the size of DFL and AFL are also influenced by the characteristics of the active zone in its habitat. By contrast, CPH size in male and female adults shows no difference based on the mean values, 22.40 mm and 23.44 mm respectively. However, the average size of juvenile CPH differs significantly from the adult group, accounted for 16.80 mm. Instead of included as as the distinguishing character between male and female adults, CPH size may differentiate among juvenile groups. The tail character (CPH) is related to the water thrust which had been analyzed in the research of Assumpção *et al.* (2012) that *Leporinus elongatus* and *Prochilodus lineatus* are migratory fish that have different swimming speeds. CPH size on *L. elongatus* is wider than *P. lineatus*, signifying higher swimming efficiency in *L. elongatus* for migrating to waters with higher surface level and fast-flowing water. Having said that, CPH size in *L. melanopterus* adults show that the adult group has a better propulsive force than the juvenile group.

The data distribution of adult females (KL 01, KL 02, KL 03, KL 05, and KL 28) were located farthest or exceeding the data distribution of adult males. KL 01 and KL 28 are located further because the two individuals had the largest measurement results on all characters, especially the SL character. Compared to males, the two *L. melanopterus* females (KL 01 and KL 28) possess much larger SL size. The same result was also obtained in the study of Mohaddasi *et al.* (2013), related to the morphometric variations of the *Alburnus chalcoides* population from four different locations in the Caspian Sea. *A. chalcoides* females (*Actinopterygii, Cyprinidae*) in the four populations showed SL value greater than males. Based on this study, the large size of female SL might be affected by habitat differences.

Each habitat has environmental characteristics that can affect the fish growth process. Based on the research by Kitano *et al.* (2007), *Gasterosteus aculeatus* females have larger SL than males from wild-caught populations. Otherwise, SL is not a sexual dimorphism character in laboratory-reared fish which indicating that environmental factors are highly affecting the differentiation of body size between sexes. For wild populations, the larger body size of females can represent a higher degree of fecundity (Baker *et al.* 1998). The larger SL size, the more productive ability to lay eggs in their natural habitat. The larger SL of *L. melanopterus* adult females might be affected by habitat differences to support reproductive success.

Interorbital Length (IL) character relates to the visual ability. Based on the measurement result, the range of IL in the adult groups (14.61-28.83 mm) was greater than the juvenile groups (12.00-16.43 mm). Based on research by Pita *et al.* (2015), zebrafish (*Danio rerio*) has a visual angle of 33° which is greater than golden shiner fish of 31°. It is caused by the interorbital distance of zebrafish is wider than golden shiner, so that the magnitude of fish vision angle towards the front is proportionate to the increase in IL size. This study reflects that wider IL may give the advantage of greater vision angle.

Three other adult females (KL 02, KL 03, and KL 05) are located farther than adult males which are affected by BL MAN. Based on the measurement results, those females have a total length of 230 mm (KL 02), 227 mm (KL 03), and 224 mm (KL 05) respectively. The total length size of adult females is smaller than adult males which are 248 mm (KL 33), 238 mm (KL 34), and 247 mm (KL 35). Although the size of the three adult females is smaller than the males, it shows that BL size of females is greater than the males. BL MAN range of the three females is 17.91-19.02 mm while males have smaller BL MAN range of 16.50-17.87 mm. Therefore, it can be concluded that the distinguishing character between *L. melanopterus* male and female adults is BL MAN size. This is in accordance with the research of Eakin *et al.* (2006) which stated that one character that can be used as a sexual dimorphism or polymorphism between individuals is barbel. It indicates that the difference between male and female is strongly affected by BL MAN as the sexual size dimorphism character.

The longer BL MAN in adult females shows better sensory ability. Based on the research of El Hag *et al.* (2012), the rapid development of Mystus nemurus barbels is closely related to the food-search function. Especially in *Cyprinidae* and catfish, barbels act as sensory organs consisting of taste buds that are sensitive to touch response (Hepher 1988). Fish with long barbels are better to detect food with a combination of touch stimuli and taste in the barbels (Wainwright 1996). Therefore, *L. melanopterus* adult females which have longer BL MAN than males represent better capability in searching for food.

From biplot, it can be seen that there is one data located at the top of quadrant I that is KL 44. Based on the biplot, this data is affected by SL character which is located in quadrant IV. The SL character vector is parallel to the KL 44 point but in the opposite direction or at the negative Y axis, while KL 44 at the positive Y axis. This can be interpreted that the direction difference shows an inverse proportionate influence on size. When compared with the results of the early measurements, it reveals that KL 44 has the smallest SL size (98.63 mm) compared to the overall sample.

The percentages of *L. melanopterus* morphometric measurement in males and females aimed to see the proportion differences within sexes. Besides, the percentage value can be used as a reference for identification and comparison of interspecies sizes. Based on the study, the character percentages of *L. melanopterus* between males and females have no significant difference. In comparison to *L. hoevenii, L. melanopterus* differs in the percentage of HL: TL and ED: HL. L. hoevenii is smaller than *L. melanopterus* which is 18.3% and 17.4% respectively (Table 3). Several character percentages namely PDL: TL, BD: TL, and SL: TL on L. hoevenii are greater with values of 40.8%, 29.1%, and 83.5% respectively (Fishbase 2018). Through the morphometric percentage, it can be concluded that *L. melanopterus* has smaller body length and width ratio, while *L. hoevenii* possesses greater ratio of head morphometric characters.

4.2. Meristic Variables of *L. melanopterus*

Morphological characters are not only determined by morphometric measurements, but also meristic characters which are also essential for species identification. Between *L. melanopterus* males and females, there is no significant difference in meristic characteristics. Overall, *L. melanopterus* has several meristic characters including body shape, mouth type, mouth position and color patterns. The body shape of *L. melanopterus* is fusiform with a silvery black body (Figure 4). Fusiform or streamlined body has advantages in swimming performance, especially for up and down movements with a high level of agility (Oliveira *et al.* 2010). This body shape character allows *L. melanopterus* adapting in complex habitats with low currents and abundant macrophytes.

L. melanopterus has complete fins includes dorsal, pectoral, ventral, anal and caudal fins (Figure 5). The fin fin formula can be written as follows: D. II. 8, P. I. 15, V. II. 8, A. II. 6, C. VI. 17, with most fins are colored in blackish red. The red color on the pectoral fin starts from the first spine to the sixth ray and aach ray of the dorsal fin is red as well as the ventral and anal fins. The caudal fin type of *L. melanopterus* is deeply forked which is red on the outer edge of the lobe (starting from third spine and the second ray) and black on the inside of each lobe (Figure 5). Based on the observation, the deeply forked type tends to taper inward so that each lobe has a relatively long size. The long caudal lobe allows triggering the acceleration of the propulsive force anteriorly, supported by the slim size of the caudal peduncle which can reduce friction with water (Assumpção *et al.* 2012).

Furthermore, the shape of lateral line continues and decreases slightly from the pectoral fin and body covered with cycloid scales. There are seven scales above the lateral line, four scales below the lateral line, 13 scales on the predorsal, 35 scales along the lateral line and 14 scales on the caudal peduncle. This is in accordance with the character of genus Leptobarbus which has scale range on the lateral line of 34-38 scales, 14-15 scales on the caudal peduncle, and downward-curve shape of the lateral line (Roberts 1989).

L. melanopterus has a protrusible mouth, located terminally and colored in black with slightly dark purple spots on the maxilla. The ventral part of the mouth consists of three pairs of branchiostegal rays which are attached to the isthmus. The number of branchiostegal in *L. melanopterus* is the same as the characteristic of the *Cyprinidae* (Rainboth 1996) (Figure 6). The main function of branchiostegal rays is supporting the branchiostegal membrane and both of these features work together affecting fish speed in capturing prey. The higher number of branchiostegal rays, the greater fish ability in catching prey quickly with water pumping mechanism (Farina *et al.* 2015). For example, red arowana (*Scleropages formosus*) has 16 pairs of branchiostegal rays and makes it possible to catch large prey such as frogs, insects, and fish quickly (Zhang and Mark 2017). Compared to *S. formosus, L. melanopterus* which has fewer branchiostegal rays reflects that it cannot pump water as fast as *S. formosus*, only allowing this species to capture smaller preys.

Another distinguishing meristic variable of *L. melanopterus* is the predorsal shape. The predorsal shape between *L. melanopterus* males and females differs significantly with steeper predorsal in males, whereas in females are more sloping. Moreover, the position of male mouth tip tends to be not parallel or lower than the fork angle. In contrast to males, females have a mouth tip position which parallels to the fork angle (Figure 4). These two meristic variables are obvious so that distinguishing female and male are easier and quicker on the field.

4.3. Anatomical Variation of *L. melanopterus*

The analysis of anatomical measurements was performed in combined (male and female) to see either the presence or absence of sexual dimorphism based on anatomy characters (Figure 11). There are five of nine characters as the main character in this analysis which are USUS, LAM, GILL. A, GILL. F, and GILL. R. Those characters lead to the distribution of adult females and males. The correlation of data distribution with the vector direction indicates that both males and females are similarly affected by these five characters. However, adult female data distribution located farther than males. It might be caused by certain characters between those five main characters.

The two main characters with the highest loading score are USUS and LAM. Based on the measurement, it can be seen that the intestinal length range in adults is 145.71-539.00 mm and the gut length range is 54.01178.00 mm. The longer size of LAM and USUS is part of the adaptation result to process large-sized foods such as plant branch and insects that can be found in the *L. melanopterus* stomach. According to Karachle and Stergiou (2010), plant branch tends to be more difficult to digest so that longer intestine aims to maximize the absorption process to fulfil nutrient needs. The intestine tract in herbivorous and omnivorous fish have thinner tunica mucosa to maximize the absorption process compared to carnivorous fish that have thicker tunica mucosa (Buddington and Diamond 1987).

The other three characters of *L. melanopterus* adults are GILL. A, GILL. F, and GILL. R. From the PCA anatomy biplot (Figure 11), the data distribution of adult female (KL 03 and KL 05) in these characters is further than the adult male (KL 33 and KL 34). Based on the measurement, females of KL 03 and KL 05 have a smaller total length which measured of 227 mm and 224 mm respectively. Compared to KL 33 and KL 34 males, these two individuals are larger with total lengths of 248 mm and 238 mm.

The adult female group with a smaller body size shows having greater sizes of GILL. A, GILL. F and GILL. R than the adult male group. The gill size in KL 03 and KL 05 ranges 2.00-3.00 mm of GILL. R, 10.32-11.00 mm of GILL. F, and 30.00-33.00 mm of GILL. A. In contrast, adult males (KL 33 and KL 34) have smaller gill size range which is 1.90-2.45 mm of GILL. R, 8.41-9.00 mm of GILL. F, and 22.00-27.49 of GILL. A. Therefore, GILL. A, GILL. F, and GILL. R can be used as a reference to distinguish between adult males and females based on anatomy characters.

Gill size correlates with the maximum ability to take O2 from the environment. Based on research by Laurent and Steve (1991), trout has a larger gill surface area than catfish (240 mm^2/g and 150 mm^2/g respectively). It is caused by higher O_2 concentrations in trout's habitat while catfish is tolerance to the low-dissolved O_2 concentrations. Larger gill size may in accordance with wider gill surface area and leads to higher demand for dissolved O_2. The large gill size in females indicates that greater O_2 requirement than in males. The gill size also indicates the circulation process in fish. *L. melanopterus* adult female has a greater body weight than adult males so it might represent a faster metabolic rate. This process must be balanced with the circulation process that occurs in the gills. The structure of gill filament is thin and numerous which helps the gas exchange process while the gill arch (as many as four pairs) acts as an attachment shaft for gill filaments. In accordance with Wegner (2011), each gill filament consists of lamellae to maximize the diffusion area and the effectiveness of gas exchange between blood and water. Therefore, the larger gill filament and gill arch size will trigger the effectiveness of the circulation and metabolic rate processes in the adult female.

Other anatomy characters are GEL. R, JTG and HEART. These three characters also lead to the distribution of *L. melanopterus* adult data or contribute to differences in adult groups with juveniles. The swim bladder is an internal organ filled with air to provide buoyancy. *L. melanopterus* swim bladder length range (anterior chamber and posterior chamber) is 38.00-92.81 mm and classified as physostome type (Figure 8). Grom (2015) stated that *Cyprinidae* generally has a physostome swim bladder. Besides physostome type, *Cyprinidae* has unique swim bladder characteristic that is the anterior chamber can contain gas ten times more than the posterior chamber (Alexander 1959). This capability can increase buoyancy efficiency and save energy when swimming. The other internal organs of *L. melanopterus* is heart, ranging from 2.50 to 13.30 mm (Figure 8). Farrell (1991) stated that the Teleostei fish circulation system is carried out by a two-chamber heart assisted by gills. The result of the Soranganba and Amita (2007) study shows that Labeo rohita (*Cyprinidae*) has the heart length of 23.00 mm with a standard length of 790 mm. Fish heart size tends to be proportionate along with the increase of body size. This aims to accelerate the circulation process in order to balance the need for O_2 which is used in a great concentration for metabolic process. Similarly, *L. melanopterus* heart size tends to increase with increasing body size as the indication of different metabolic rate in each age group.

L. melanopterus liver (HATI) length range from 30.81 to 196.00 mm. This organ is located in the abdominal cavity exactly at the dorsal part of the intestine. *L. melanopterus* liver consists of two brownish-red lobes (Figure 10). This is in accordance with the research of Mokhtar (2018), that one type in *Cyprinidae* which is grass carp (*Ctenopharyngodon idella*) has two thick liver lobes which are filled the abdominal space. Although the liver size does not act as a distinguishing character between male and female yet it can distinguish between adult and juvenile groups.

To conclude, the distinct morphometric sizes in *L. melanopterus* adult are Ventral Fin Length (VFL), Body Depth (BD), Standard Length (SL), Anal Fin Length (AFL), Caudal Peduncle Height (CPH), Dorsal Fin Length (DFL), Interorbital Length (IL), and Barbel Length Mandibulla (BL MAN), while the distinguishing morphometric character between adult males and females is BL MAN. The varied anatomical sizes of *L. melanopterus* adults are USUS, stomach (LAM), gill filament (GILL. F), gill arch (GILL. A), and gill raker (GILL. R), with the size of GILL. F, GILL. A, and GILL. R can distinguish between female and male adults.

Conflicts of Interest

The authors declare that there is no conflict of interest on this research.

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