



**MORPHOMETRIC AND MERISTIC CHARACTERS OF
MULLUS SERMULETUS (LINNEAUS, 1758) AND MULLUS
BARBATUS (LINNEAUS, 1758) FROM BENGHZI COAST –
MEITERRNEN SEA – EASTERN LIBYAN**

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الخصائص المورفومترية والميرستية لثوعين من اسماك التريليا الحجرية واسماك
التريليا الرملية في ساحل بنغازي – البحر المتوسط – شرق ليبيا

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الملخص

في البحث الحالي تم الكشف عن اختلافات داخل النوع وبين الأنواع الأخرى في المؤشرات المورفولوجية لـ 450 من أسماك التريليا الحجرية *Mullussermuletus* و 411 من أسماك التريليا الرملية *Mullus barbatus*، من البحر الأبيض المتوسط في بنغازي، خلال الفترة من يناير إلى ديسمبر 2022. أظهر نوع القياسات المورفولوجية أن الذكور أظهروا قياسات متساوية ومثالية النمو أكثر من الإناث لكلا النوعين المدروسين. تختلف الخصائص المرستيمية بشكل كبير بين النوعين المدروسين. لم يتم العثور على ازدواجية الشكل الجنسي في الخصائص المرستيمية للثوعين قيد الدراسة بلغ طول سمكة التريليا الحجرية ما بين 11.5 إلى 18.9 سم لـ 189 ذكرًا و 12.5 إلى 19.9 سم لـ 261 أنثى. تراوحت أوزانها من 18.43 إلى 79.42 جرام للذكور ب = 3.054 و 20.14 إلى 99.02 جرام للإناث ب = 2.887. تراوحت أطوال الأسماك التريليا الرملية من 10.5 إلى 17.9 سم لـ 185 ذكرًا ومن 11.5 إلى 18.9 سم لـ 226 أنثى. بلغ وزن الذكور ما بين 24.34 و 112.42 جرامًا (ب = 3.029)، بينما بلغ وزن الإناث ما بين 18.04 و 83.02 جرامًا (ب = 2.856). تم حساب سمات مثل عدد الصفائح الخيشومية وعدد الأشعة في الزعانف الظهرية والصدريّة والذيلية. أظهرت النتائج عدم وجود فروق في هذه السمات بين الذكور والإناث من نوعين مستهدفين من ساحل بنغازي في البحر الأبيض المتوسط، شرق ليبيا.

الكلمات المفتاحية: التريليا الحجرية ، التريليا الرملية ، القياسات المورفولوجية، السمات المرستيمية، ساحل بنغازي، البحر الأبيض المتوسط - شرق ليبيا.

Abstract:

In the present investigation, Intra-and inter-specific variations in morphometric indices of 450 *Mullussermuletus* and 411 *Mullus barbatus*, from Mediterranean Sea at Benghazi, were revealed during the period from January to December 2022. The type of allometry of morphometric measurements showed that for both species studied, males showed isometric measurements more than females for both studied species. Meristic characters are significantly different between the two species studied. No sexual dimorphism was found in the meristic characters of the two species under study. The fish *Mullussermuletus* measured between 11.5 to 18.9 cm in length for 189 males and 12.5 to 19.9 cm for 261 females. Their weights ranged from 18.43 to 79.42 grams for males $b = 3.054$ and 20.14 to 99.02 grams for females $b = 2.887$. The fish, *Mullus barbatus*, ranged in length from 10.5 to 17.9 cm for 185 males and from 11.5 to 18.9 cm for 226 females. Males weighed between 24.34 and 112.42 grams ($b = 3.029$), while females weighed between 18.04 and 83.02 grams ($b = 2.856$). Features like the overall amount of rakers on the gill, rays number in dorsal, pectoral, and caudal fins were counted. The results showed no differences in these features between males and females of two target species from the Benghazi coast in the Mediterranean Sea, eastern Libya.

Keywords: *Mullussermuletus* , *Mullus barbatus*, Morphometry, Meristic characters, Benghazi coast , Mediterranean Sea - Eastern Libyan.

1.Introduction:

Numerous researchers have determined that fish morphometric characteristics are taxonomically significant for identifying species, sex, and race (Lawson, 2010; Simon et al., 2010; Elamin et al., 2011; Mekkawy and Mohammad, 2011; Mazlan et al., 2012; Deepti et al., 2013; Sajina et al., 2013; Uiblein and Heemstra, 2010; Abbaspour et al., 2013; Safi et al., 2014; Jawad, 2015; Masood et al., 2015; Zubia et al., 2015 and Mahmoud et al., 2016). According to several studies (Lawson, 2010; Simon et al., 2010 and Elamin et al., 2011), the meristic characters were also found to be valid for sex, race, and species identification. Family: One of the most profitable and costly fish families in Libya that is mostly targeted by trawl fishing is the goatfish, or Mullidae, which make up over 13% of all trawl landings in Libyan Mediterranean waters (Elbaraasi et al., 2019). Four of the six taxa in the

family Mullidae—*Mullus*, *Upeneus*, *Pseudupeneus*, and more recently, *Parupeneus*—are found in the Mediterranean Sea (Golani, 1994). *Mullussurmuletus* and *Mullus barbatus*, the two principal species of the family Mullidae, are among the principal target species of the Libyan Mediterranean demersal fisheries (Elbaraasi et al., 2019). A significant commercial goatfish species, the striped red mullet (*Mullussurmuletus*, Linnaeus 1758) can be found on sand bottoms as shallow as 5 meters (16 feet) to as deep as 409 meters (1, or 342 ft) in the Black Sea, eastern North Atlantic Ocean, and Mediterranean Sea. The species can reach up to 40 centimeters (16 inches) SL, however the majority are only around 25 centimeters (9.8 in) SL (Ben-Tuvia, 1990). Using trammel nets near Benghazi, Libya (Southern Mediterranean), a new overall length record of 33.6 cm x 398.3 g was captured on November 14, 2022 (Said et al., 2023). The goatfish species *Mullus barbatus*, also called red mullet (Linnaeus, 1758), is found from Scandinavia to Senegal in the Mediterranean Sea, the Sea of Marmara, the Black Sea, and the eastern North Atlantic Ocean (Ben-Tuvia, 1990). The meat is quite valuable, and trawling is the main method of catching them. It is a demersal fish that lives between 10 and 328 meters (30 and 1,080 feet) below the surface on muddy, sandy, or rocky and gravel bottoms. Crustaceans, bivalve mollusks, and polychaete worms are the main food sources for the carnivorous red mullet (Hureau, 1986). As sensory organs, the barbells aid in locating prey. April and May are when spawning takes place (Muus and Nielsen 1999). The current study aims to evaluate the morphometric and meristic characteristics used to reveal intra- and inter-specific variations of striped red mullet (*Mullussurmuletus*, Linnaeus, 1758) and red mullet (*Mullus barbatus*, Linnaeus, 1758) from Mediterranean sea at Benghazi coast, Libya, in order to assess the commercial potential of *M. surmuletus* and *M. barbatus* stocks in the Mediterranean Sea, Eastern Libya.

2. Materials and Methods

Samples were collected on fishing trawlers from the Benghazi coast in the eastern Libyan Mediterranean Sea between January and December 2022 (Fig. 1). 450 specimens of *M. surmuletus* and 411 specimens of *M. barbatus* were examined.

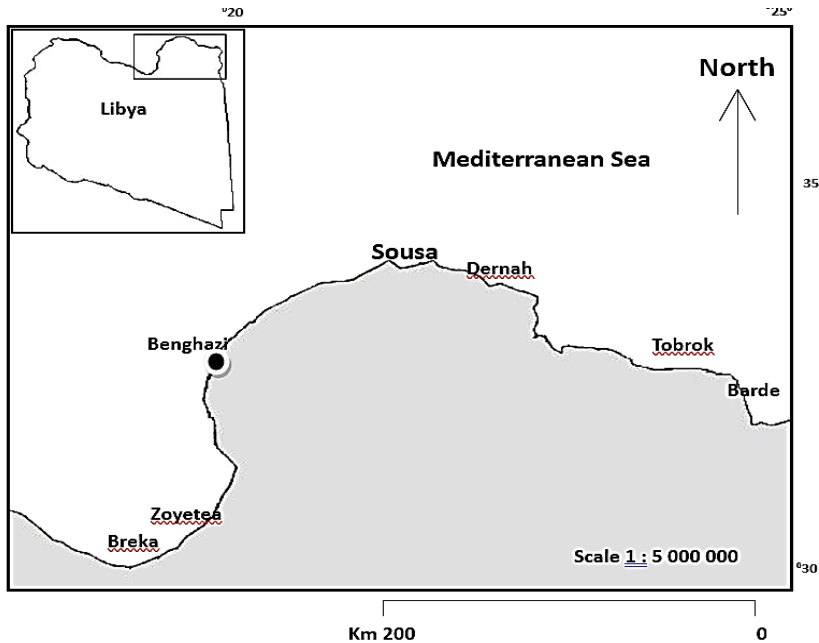


Figure 1: Map displaying the collecting location on the eastern Libyan Mediterranean coast near Benghazi

Total weight (to the closest g) and total length (TL) were measured to the closest cm.

Morphometrics:

In the current study, 261 females (12.5–19.9 cm) and 189 males (11.5–18.9 cm) of *Mullus surmuletus* and 226 females (11.5–18.9 cm) and 185 males (10.5–17.9 cm) of *Mullus barbatus* were picked at random from the Mediterranean, shore of Benghazi, Eastern Libya, between January and December 2022. This subgroup of gonads was used to test the hypothesis that there is no sexual dimorphism in the morphometric and meristic properties of *Mullus* spp. Sex was determined by macroscopically examining the gonads. Twelve morphometric measures were made on each fish's left side, to the nearest millimeter, with a divide and an accurate measurement tablet.

The morphometric measurements included:

- 1- Length Total (TL)
- 1. 2. Length Standard (SL)
- 2. Body Depth (BD)

3. Length of Head (HL)
4. Diameter of the Eye (ED)
5. Postorbital Length (POSL)
6. Length of Pectoral Fin (PFL)
7. Length of Dorsal Fin (DFL)
8. Length of Anal Fin (AFL)
- 10-Caudal Peduncle Depth (CPD)
- 11- Post Dorsal Length (PDL)
- 12- Total Weight (TW).

The Meristics measurements included:

Mullusspps. meristic measurements of 70 ♂ and 91 ♀ were taken into consideration. Meristic counts were noted as follows:

- 1- DFR - Dorsal Fin Rays
- 2- PFR - Pectoral Fin Rays
- 3- CFR - Caudal Fin Rays
- 4- The overall count of gillrakers (TNGR)

Using the formula $W = a * L^b$, where W is the total weight in grams (g), L is the total length in centimeters, a is the equation's intercept, and b is its slope, Le Cren (1951) established the length-weight relationship.

Statistical analysis:-

The basic statistics (mean, standard error and range) of certain morphometric indices (relative to standard length, SL or head length, HL) and meristic characters were estimated. The allometric coefficients of the raw morphometric characters and their relationships with fish size (SL) were estimated using power function equation and the linear regression model respectively. The simple power function or allometry equation of Huxely (1932):

$$Y = a X^b$$

was used, where Y and X are dependent and independent variables respectively and a and b (the allometric coefficient) are constants. The parameters a and b of this equation were estimated by fitting a linear equation to the logarithmic values of Y and X according to the least square method. This leads to an equation of the form:

$$\text{Log } Y = \text{Log } a + b \text{ Log } X$$

Additionally, by evaluating the confidence limits of the allometric coefficients— isometry (I), negative allometry (-), or positive allometry (+)—the kind of allometry was identified. By confirming the

importance of the allometric coefficients (b)— $b=1$, $b>1$, and $b<1$ for isometric growth, positive allometric growth, and negative allometric growth, respectively—that function as a standard for the degree of differential increase in the morphological measurements in relation to a specific reference length, the type of allometry was assessed. It was discovered that this kind of allometry was useful for researching *Mullus surmuletus* and *Mullus barbatus* intra- and inter-specific variation. The t-test was used to verify the mean values of the meristic traits both within and between the species under consideration. Statistical analyses for morphometric and meristic data were performed using the SPSS version 18 software package and Excel (Microsoft office, 2007).

3.Results and Discussion

Relationship between length and weight:

Figures 2 and 3 display the findings of the study, which examined the correlation between length and weight in 450 *Mullus surmuletus* fish samples (189 males and 261 females). The male fish weighed between 18.43 and 79.42 grams and measured between 11.5 and 18.9 cm in length. The female fish weighed between 20.14 and 99.02 grams, and her T.L. ranged between 12.5 and 19.9 centimeters. Males showed isometric growth with a relationship " b " value of approximately 3, whereas females showed a tendency toward negative allometric growth with a " b " value of less than 3. (2.887). The total length and weight data for ♂ and ♀ were compared using a t-test, and the results indicated a significant difference at $p < 0.01$. For commercial fishes, length-weight relationships are frequently available because they make it simple to convert length to weight and vice versa (Cherif et al. 2007). Comparing different geographical areas and using stock assessment models can both benefit from the same equation (Kolher et al. 1995; Gonçalves et al. 1996; Froese and Pauly 1998 and Moutopoulos and Stergiou 2002). The present study's functional regression b values for *M. surmuletus* (3.054 for males and 2.887 for females) revealed negative allometric growth for females and isometric growth for males, which is consistent with findings from earlier research. However, there are some variations in b values according to the examination of the length-weight connections provided by multiple writers (Table 1). Salinity, temperature, sex, diet, season, and maturity stage are some of the

variables that can lead to these variations in b values (Shepherd and Grimes 1983; Pauly 1984; Cherif et al. 2007).

Table (1): Total length-total weight relationships of *M. surmuletus* reported by various studies

Author	Year	Region	b Males	b Females
In the Present study	2022	Benghazi coast	3.054	2.887
Gharbi and Ktari	1981	Tunus	3.001	2.855
Abdallah	2002	Egypt	3.051	2.812
Outruki and Tsikras	2003	Greece	3.511	2.768
Ilihn et al.,	2009	Izmer Bay	3.122	2.801
Arslen and Ismen	2013	Northern Aegean Sea	3.098	2.789
Mahmoud et al.,	2016	Mediterranean Sea, Egypt	3.084	2.881

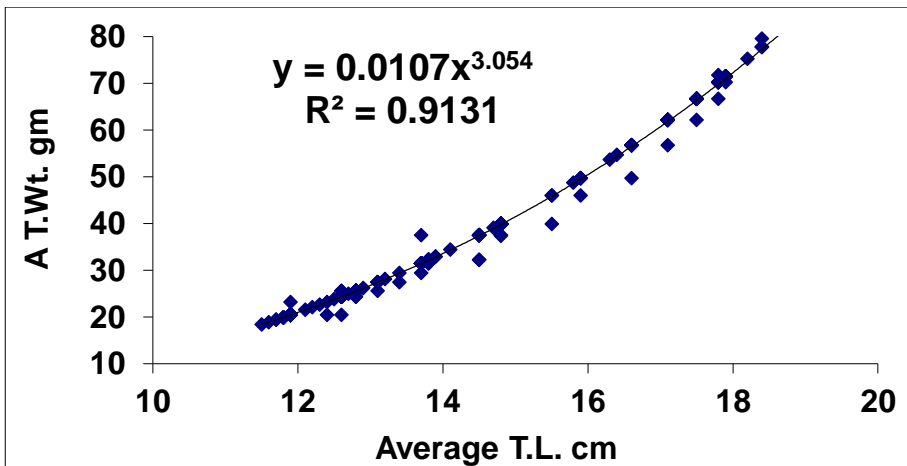


Figure (2). The relationship between average total length and average total weight of 189 males *Mullussurmuletus* from the

Benghazi coast during the period from January till December 2022.

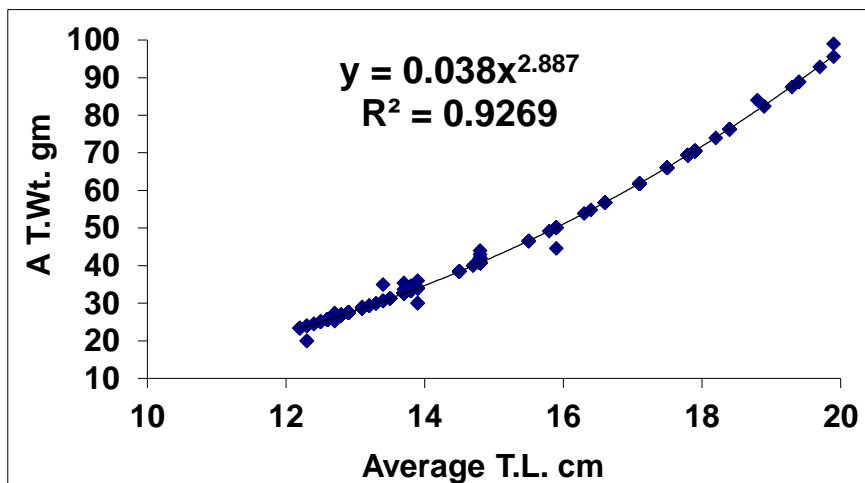


Figure (3). The relationship between average total length and average total weight of 261 females *Mullus surmuletus* from the Benghazi coast during the period from January till December 2022.

The results of the study, which looked at the relationship between length and weight in 411 fish samples from *Mullus barbatus* (185 males and 226 females), are shown in Figures 4 and 5. The male fish ranged in length from 10.5 to 17.9 cm and weighed between 24.34 and 132.42 grams. The female fish's T.L. ranged from 11.5 to 18.9 cm, and her weight ranged from 18.14 to 83.02 grams. The relationship's "b" value was around 3, indicating isometric growth for males (3.029) while in females "b" less than 3, indicating a tendency toward negative allometric growth, for females (2.856). The total length and weight data for males and females were compared using a t-test, and the results indicated a significant difference at $p < 0.01$.

In line with previous research, the functional regression b values for *M. barbatus* in this study showed negative allometric growth for females and isometric growth for males (3.029 for males and 2.856 for females). Nevertheless, the analysis of the length-weight relationships supplied by several authors indicates some differences in b values (Table 2).

Table (2): Total length-total weight relationships of *M. barbatus* reported by various studies

Author	Year	Region	b Males	b Females
In the Present study	2022	Benghazi coast	3.029	2.856
Vassilopoulou	1992	Aegean Sea	3.117	2.775
Tursi et al.,	1994	Ionian Sea	3.243	2.867
Talet et al.,	2016	Mediterranean Sea, Algeria	3.091	2.888
Mehanna and Hussanien	2023	Mediterranean Sea, Egypt	3.121	2.809

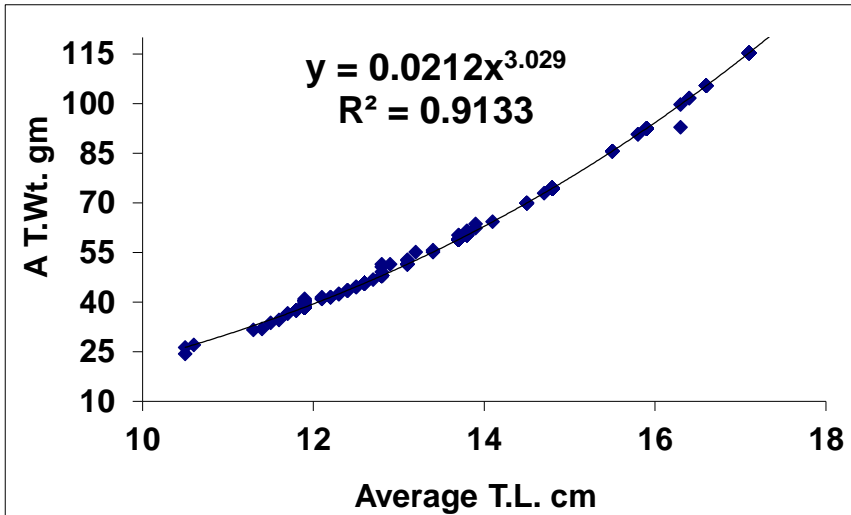


Figure (4). The relationship between average total length and average total weight of 185 males *Mullus barbatus* from the Benghazi coast during the period from January till December 2022.

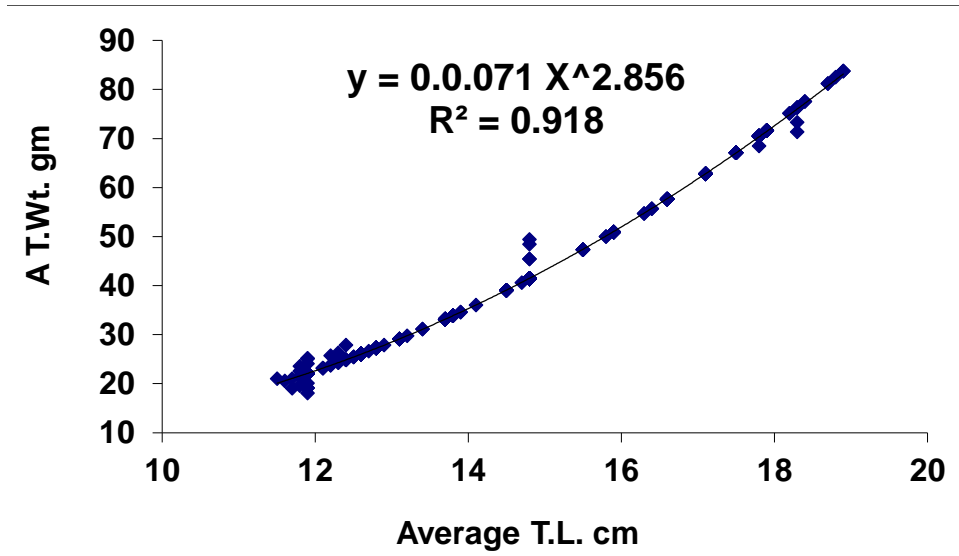


Figure (5). The relationship between average total length and average total weight of 226 females *Mullus barbatus* from the Benghazi coast during the period from January till December 2022.

Meristic characters:

The morphometric and meristic characteristics of *Mullussurmulatus* collected from the Benghazi shore between January and December 2022 are listed in Table 3:

Character	Presently reported study Males	Presently reported study Females
Number of specimens	189	261
Total length [TL cm]	11.5 -18.9	12.5 - 19.9
Total weight (TWt gm)	18.43 - 79.42	20.14 - 99.02

Standard length [SL cm]	10.2– 17.1	11.2 – 17.3
Body Depth [BD cm]	3.18	3.19
Head Length [HL cm]	3.06	3.08
Eye Diameter [ED cm]	0.81	0.81
Postorbital Length [POSL cm]	1.31	1.31
Pectoral Fin Length [PFL cm]	1.32	1.32
Dorsal Fin Depth [DFD cm]	0.47	0.47
Dorsal Fin Length [DFL cm]	1.46	1.46
Anal Fin Length [AFL cm]	1.17	1.17
Caudal Peduncle Depth [CPD cm]	2.48	2.48
Post Dorsal Length [PDL cm]	6.12	6.12
Dorsal Fin Rays Count [DFRC]	9	9
Pectoral Fin Rays Count [PFRC]	15	18
Count of Caudal Fin Rays [CFRC]	7	8
The overall count of gill rakers (TNGR)	67	68

The morphometric and meristic characteristics of *Mullus barbatus* collected from the Benghazi shore between January and December 2022 are listed in Table 4:

Character	Presently reported study Males	Presently reported study Females
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Number of specimens	185	226
Total length [TL cm]	10.5 -17.9	11.5 - 18.9
Total weight (TWt gm)	24.34 - 112.42	18.41 - 83.02
Standard length [SL cm]	9.2– 16.1	10.2 – 17.3
Body Depth [BD cm]	3.11	3.12
Head Length [HL cm]	3.02	3.03
Eye Diameter [ED cm]	0.80	0.81
Postorbital Length [POSL cm]	1.32	1.33
Pectoral Fin Length [PFL cm]	1.33	1.33
Dorsal Fin Depth [DFD cm]	0.46	0.47
Dorsal Fin Length [DFL cm]	1.45	1.45
Anal Fin Length [AFL cm]	1.16	1.16
Caudal Peduncle Depth [CPD cm]	2.45	2.45
Post Dorsal Length [PDL cm]	6.02	6.02
Dorsal Fin Rays Count [DFRC]	9	9
Pectoral Fin Rays Count [PFRC]	15	16
Count of Caudal Fin Rays [CFRC]	8	8
The overall count of gill rakers (TNGR)	65	66

The findings demonstrated that male and female *Mullus spp.* do not differ physically. The proportions of the fish in our study did not differ significantly from those of fish from other Mediterranean regions when

we evaluated their body sizes and countable traits (Lawson, 2010 and Simon et al., 2010). Because body measures and countable traits can demonstrate changes brought on by the environment, they remain dependable methods for identifying fish species, particularly in the field (Elamin, et al., 2011). Furthermore, fish populations have been identified and their habitats have been understood thanks to these measurements and characteristics (Mazlan et al., 2012). The body measures and measurable characteristics of *Mullus spp.*, which is located along the Benghazi shore in the Mediterranean Sea in Eastern Libya, were the main focus of this study. Fish populations vary in shape and appearance due to a variety of environmental conditions. These variables include water depth, velocity, oxygen content, radiation, temperature, and salt content (Lindsey 1988 and Turan 2000). When comparing groups of the same fish species, these differences—known as phenotypic variants—can include variances in body sizes and countable features (Jayasankar et al. 2004). These characteristics have been widely used to distinguish between various fish groups that are captured for fishing (Murta 2000). Disparities in gender, sources of food, prey of predator- interactions, physical circumstances, and environmental factors all contribute to these variances in body shape and characteristics among fish of the same species (Dasgupta 1991).

In conclusion, Males displayed more isometric measurements than females for both species under study, according to the type of allometry of morphometric data. The two species under study have quite different meristic traits. The meristic characteristics of the two species under investigation showed no signs of sexual dimorphism.

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Conflicts of Interest

Declare conflicts of interest or state the "Authors declare no conflicts of interest". Authors must identify and declare any personal circumstances or interest that may be perceived as inappropriately influencing the representation or interpretation of reported research results.

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