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Morphometric Characters and Meristic Counts of *Mastacembelus armatus* (Lacebede, 1800) from Maruthur Anicut, Tirunelveli District, India

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Authors' contributions

This work was carried out in collaboration among all authors. Author MS designed the work, wrote the protocol, collected the samples, and measured the morphometry characters and meristic counts. Author JAR performed statistical analysis for the collected data. Author RP critical interpretation of the analyzed data and literature. All authors read and approved the final manuscript.

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ABSTRACT

The present study highlights about morphometric measurement and meristic count of *Mastacembelus armatus* (Lacebede, 1800) collected from the Maruthur wetland ecosystem have been investigated with 23 specimens to observe the relationship between morphometric characters. Identification of species is an initial step in any research work and plays a vital role in the behavioural study. Morphometric character analysis and meristic counts are considered as simplest and authentic methods for fish species identification which is termed as morphological systematics. Fourteen different morphometric characters in percentage of total fish length (9 characters), head length (5 characters), and five different meristic counts (branched and unbranched rays) have been studied. The obtained result reveals that morphometric characters vary depending on the growth and size of the fish. However, the meristic counts were comparatively similar. All the characters show a positive correlation both in the percentage of total length and head length. The different morphometric and meristic counts of *M. armatus* have been analyzed for the population dynamics which includes taxonomy study and proper identification of fishes. The fin formula was calculated for some hard rays and soft rays. Therefore, this study supplement additional data for the identification of the fish species.

Keywords: Maruthur dam; Mastacembelus armatus; morphometric character; meristic count.

1. INTRODUCTION

The *Mastacembelus armatus* (Spiny eel) are tropical freshwater fish belonging to the Mastacembelidae family. They are commonly known as Spiny or Zig-zag eel, which occurs in areas with rocky bottoms in the mainstream during the dry season but enters canals, lakes, and other flat plains and hill areas during the flood season. It is reported as one of the good edible fish and also used for aquarium trade [1]. "The movement pattern of the fish is fully migrant and not considered to be a true eel Angilluilidae but like all members of the Mastacembelidae family. It has an elongated body (like eel) structure, a long snout with 33 to 35 dorsal spines and one ventral hard spine, and in general about 4 inches long both the dorsal and anal fins are extended and joined to the caudal fin" [2].

"This fish can reach just over 90 cm in length in the wild, though they will not generally exceed about 50 cm in captivity. It has a life span of 8 to 18 years and its background coloration is a tan to light brown and dark horizontal strips with a rectangular pattern running throughout the head along the entire length of its body, reaching vertically from its back to its belly, a pattern with a series of irregular dark markings. These markings generally have a zig-zag appearance which has been used as a common name for this as well as several other species of spiny eel. But this fish grows and reaches close to 91 cm and above in length, an adult requires a very large aquarium. In nature, these fish are omnivorous and feed at night on benthic insect larvae, worms, and other invertebrates, but they will also eat some plants" [3].

"Identification of species is an initial step in any research work and plays a vital role in the behavioural study. Morphometric character analysis and meristic counts are considered as simplest and authentic methods for fish species identification which is termed as morphological systematics" [4]. "In general, fish appear greater variances in morphological traits both within species and between populations than other vertebrates and are more susceptible to environmentally induced morphological variations" [5].

"The morphometric characters and meristic counts may range from variability to intraspecific which is under the influence of environmental parameters due to the cause of variation" [6-10]. "To determine possible differences between separate unit stocks of the same species and assess the wellness of individuals, the morphometric relationships between various body parts of fish can be used" [11].

"Fishes are very perceptive to environmental changes and adapt themselves immediately by dynamic necessary morphometrics" [12]. Information about the morphometric measurements of fishes and the study of the statistical relationship among them is essential for compartmentalization taxonomic work [13]. Vladykov [7] and Tandon *et al.* [14] observed that morphometric characters can be effectively

utilized for ascertaining the genetically controlled and environmentally controlled characters. Based on range difference, the various morphometric characters have been categorized into genetically (narrow range), intermediate (moderate range), and environmentally (vast range) controlled characters [15]. "The information regarding population structure and enlisting pattern of a fish species is highly required and considered as an authentic source before initiating its proper conservation and management, otherwise, it can lead to phenomenal changes in productivity and biological attributes of a species 1-3" [16]. In fishes, the first step towards their conservation is accurate identification. These examinations require exact measurements and counts of fin ray elements. Hence the present study was intended to come up with information on morphometric and meristic characteristics of the fish, *Mastacembelus armatus* from Maruthur dam Tirunelveli, Tamil Nadu.

2. MATERIALS AND METHODS

2.1 Species Collection

A total number of 23 specimens of *Mastacembelus armatus* (spiny eel) (Fig. 1) were collected from Maruthur Anicut with the help of standard fishing rod and hand nets from December 2022 to April 2023. The specimens were preserved in a 5% formaldehyde solution on the spot. Fishes were brought to the laboratory for further analysis. The meristic counts and morphometric measurements were recorded using digital vernier caliper.

Fig. 1. *Mastacembelus armatus* specimens A- Mouth Modification, B- Head Portion, C- Experimental Fish, D- Dorsal Spines and E- Ventral Spine

2.2 Analysis of Morphometric Characters

During our study, fourteen different morphological characters and six meristic characters were analyzed: **In percentage of total fish length**: Standard length, Pre-dorsal length, Dorsal fin base, Head length, Head depth, Pectoral fin base, Anal fin base, Highest Body depth and Least body depth. **In percentage of Head length**: Lower jaw length, Upper jaw length, Eye diameter, Preorbital length and Postorbital length. **Meristic characters**: Dorsal spines, Dorsal fin rays, Anal fin rays, Caudal fin rays, Pectoral fin rays and Branchiostegal rays.

2.3 Statistical Analysis

Mean, median, mode, standard deviation, range difference, regression equation, and Karl Pearson's correlation coefficient were calculated by the method of Snedecor [17] in Microsoft Office Excel.

2.3.1 Correlation coefficient

Karl Pearson's correlation coefficient was calculated between the two variable different body morphometric characters with the total length and head length of the fish to find the linearity and covariance (strength and direction of relationship) between the characters which can range between -1.00 and 1.00 by using the formula [18].

$$r = \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{\left[N\sum x^2 - (\sum x)^2\right]\left[N\sum y^2 - (\sum y)^2\right]}}$$

Where '*N*' is the number of individuals, '*x*' is the total length or head length, and '*y*' is the morphometric characters that were measured in percentage of total length and head length of the fish.

2.3.2 Regression equation

The regression equation was analysed for the estimation of relationship between a dependent variables and one or more independent variable with the following formula [18].

$$Y = a + bX$$

Where '*Y*' is the independent variable which is the standard length, body depth, etc., '*a*' is the constant value that is to be determined, '*b*' is the regression coefficient and '*X*' is the independent variable which is the total length and head length.

3. RESULTS AND DISCUSSION

In the present study, the maximum total length and weight of *Mastacembelus armatus* (spiny eel) were recorded as 66 cm and 382 g respectively. Likewise, Rashid et al., [19] analyzed the morphometric characters of hill stream fish *M. armatus* from Garhwal Himalaya in which the maximum length of the fish was recorded as 60 cm and weight of 250 g these results are more or less in a similar range to our record. Also the previous survey by Sokheng [1] reported the maximum length of *M. armatus* was 90 cm and Huang *et al*., [20] reported a maximum weight of 500 g which is a higher range than our record that could be the habitat that they were surviving.

The growth of different body morphometric characters was analyzed using two independent characters. Totally fourteen characters of *M. armatus* were statistically analyzed in which nine characters were analyzed in percentage of Total length; Standard length (SL), Pre-dorsal length (PDL), Dorsal fin base (DFB), Head length (HL), Head depth (HD), Pectoral fin base (PFB), Anal fin base (AFB), Highest body depth (HBD) and Least body depth (LBD). Five different characters were analyzed in the percentage of Head length; Upper jaw length (UJL), Lower jaw length (LJL), Eye diameter (ED), Preorbital length (PrOL) and Postorbital length (PsOL). Here almost all the characters are highly correlated indicating that these characters are directly proportional to each other (Table 1), which means the characters analyzed in the percentage of head length are influenced by the total length of the fish. Linear relationships of characters of *M. armatus* have been observed between all independent and dependent variables. The data collected was not characterized based on sex; the overall pooled data was considered.

During the study, six meristic characters have been counted for *M. armatus*, Dorsal fin rays (73-76), Anal fin rays (93-96), Caudal fin rays (19-22), Pectoral fin rays (25-28), Branchiostegal rays (5) and dorsal spines (34-35) (Table 2). In addition to that this fish contains one ventral spine these (Dorsal and ventral) spines make it difficult to handle this fish in live condition during measurement and mishandling causes injuries and severe pain so proper protection/care is

Table 1. Mean, Standard Deviation, Range, Range difference, Correlation coefficient (r), and Regression equation (Y= MX+C) between different morphometric characters of *Mastacembelus armatus* (Lacebede, 1800)

S.No.	In Percentage of Total Length	Mean	S.D	Range	Range Difference	Correlation Coefficient	Regression Equation
1	Standard Length	36.71	11.90	23.6 - 63.8	40.2	0.99	y = 0.924x + 1.548
2	Pre-Dorsal Length	23.05	7.07	15.5 - 38.6	23.1	0.98	y = 0.543x + 2.392
3	Dorsal Fin Base	13.93	5.02	7.7 - 24.8	17.1	0.96	y = 0.378x - 0.444
4	Head Length	5.88	1.52	4.2 - 8.8	4.6	0.95	y = 0.113x + 1.549
5	Head Depth	2.53	0.69	1.8 - 3.8	2	0.96	y = 0.052x + 0.539
6	Pectoral Fin Base	0.94	0.28	0.6 - 1.4	0.8	0.81	y = 0.019x + 0.177
7	Anal Fin Base	0.74	0.29	0.4 - 1.3	0.9	0.90	y = 0.018x + 0.070
8	Highest Body Depth	3.1	0.74	2 - 4.4	2.4	0.88	y = 0.051x + 1.147
9	Least Body Depth	0.78	0.26	0.4 - 1.3	0.9	0.90	y = 0.019x + 0.013
	In Percentage of Head Length	**Mean**	**S.D**	**Range**	**Range Difference**	**Correlation Coefficient**	**Regression Equation**
10	Upper Jaw Length	2.07	0.65	1.2 - 3.6	2.4	0.89	y = 0.379x - 0.157
11	Lower Jaw Length	1.4	0.46	0.7 - 2.3	1.6	0.88	y = 0.269x - 0.189
12	Eye Diameter	0.48	0.11	0.3 - 0.7	0.4	0.91	y = 0.066x + 0.09
13	Pre-Orbital Length	1.99	0.50	1.4 - 3.1	1.7	0.97	y = 0.318x + 0.115
14	Post-Orbital Length	2.47	0.60	1.7 - 3.8	2.1	0.97	y = 0.385x + 0.205

Table 2. Meristic characters of *Mastacembelus armatus* (Lacebede, 1800) and their range value

Meristic Characters	Range
Dorsal Spines	34 – 35 (XXXIV – XXXV)
Dorsal Fin Rays	73 – 76 (8 – 12 / 61 – 65)
Caudal Fin Rays	19 – 22 (2 – 4 / 15 – 20)
Anal Fin Rays	93 – 96 (16 – 28 / 65 – 80)
Pectoral Fin Rays	25 – 28 (3 – 7 / 18 – 25)
Branchiostegal Rays	5
In Fin Formula: Dorsal Spines DS. XXXIV – XXXV, Dorsal D. 8 – 12 / 61 – 65, Pectoral P1. 3 – 7 / 18 – 25, Anal A. 2 – 4 / 15 – 20, Caudal C. 16 – 28 / 65 – 80.	

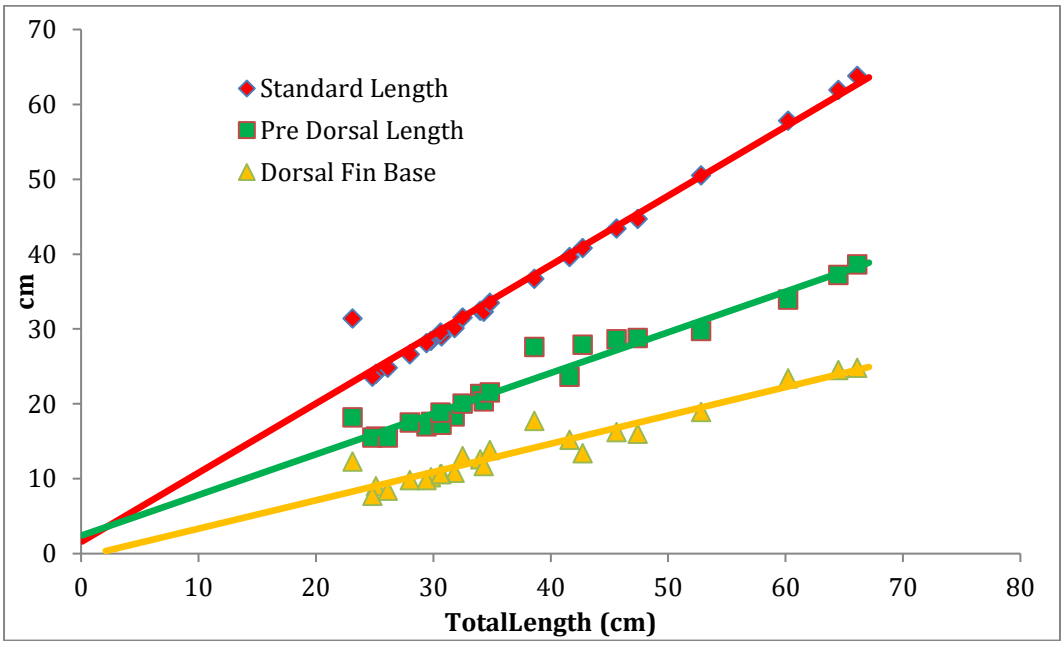

Fig. 2. Graphical representation showing the relationship of SL, PDL and DFB

needed. Similarly, the previous study by Mahmud et al [21] on the meristic count of *M.armatus* collected from the back swamp region of Kishoreganj, Bangladesh was reported as Dorsal din rays (73-89), Anal fin rays (73-83), Caudal fin rays (17-21), Pectoral fin rays (18-21), Branchiostegal rays (6) and Dorsal spines (36-39). Also the previous study by Kottelat [22], reported the dorsal fin rays (67-82), anal fin rays (67-83) and dorsal spines (33-40). While comparing our results with the previous studies, all the meristic characters count are more similar to each other which indicates the conformation of the respective species as *Mastacembelus armatus*. The data on meristic characters also indicates that every species has its specific meristic count which may vary between the different species and not between the individuals of the same species. In rare cases due to some mutation or genetic disorder, the count may vary. The different morphometric and meristic counts of *M. armatus* have been analyzed for the population dynamics which includes taxonomy study and proper identification of fishes.

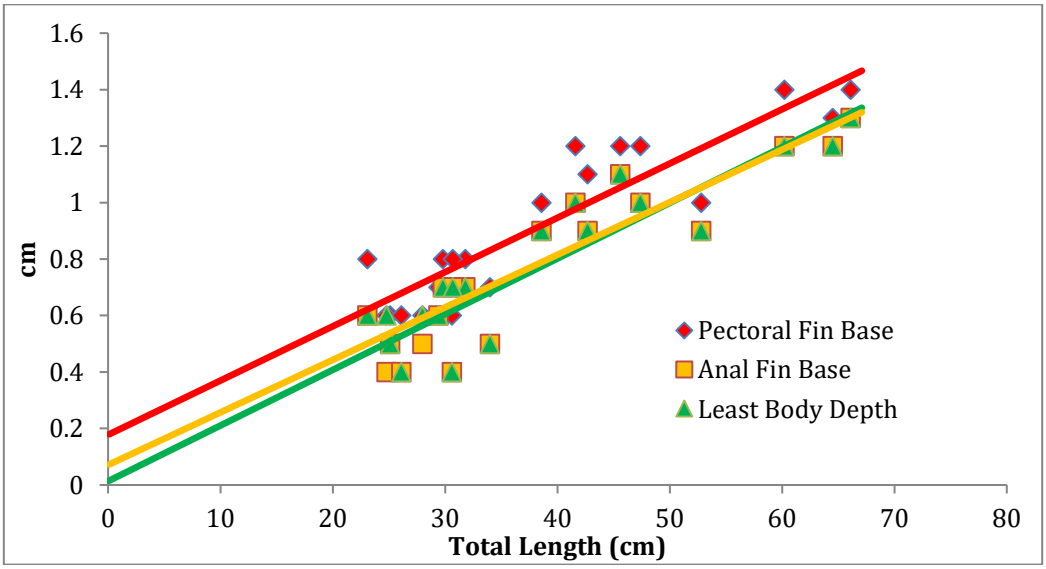

Fig. 3. Graphical representation showing the relationship of PFB, AFB and LBD

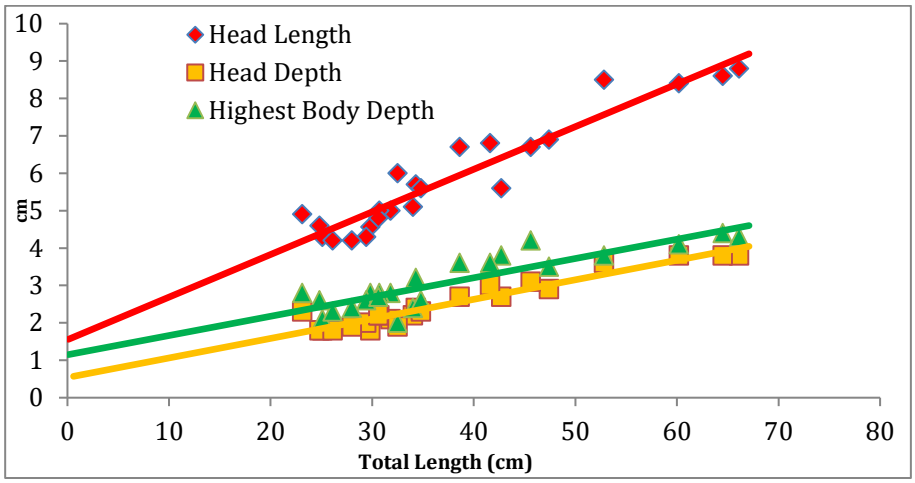

Fig. 4. Graphical representation showing the relationship of HL, HD and HBD

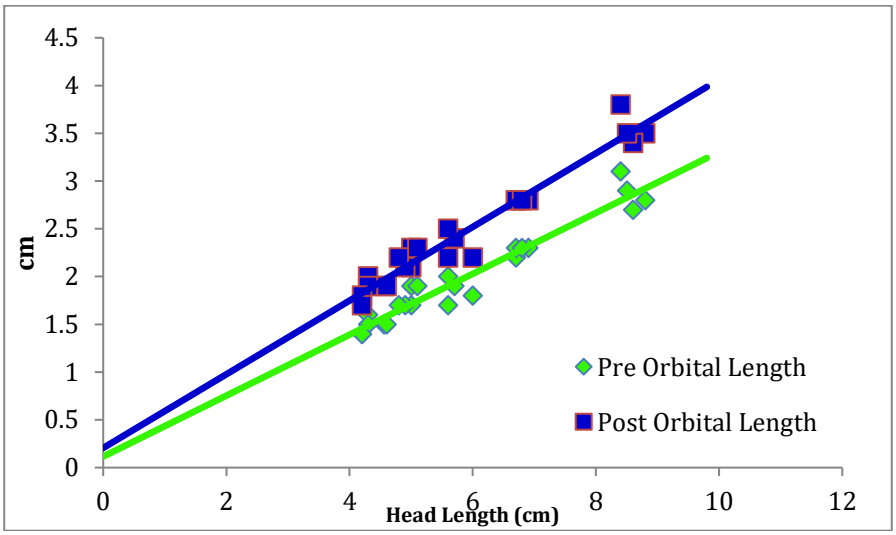

Fig. 5. Graphical representation showing the relationship of PrOL and PsOL

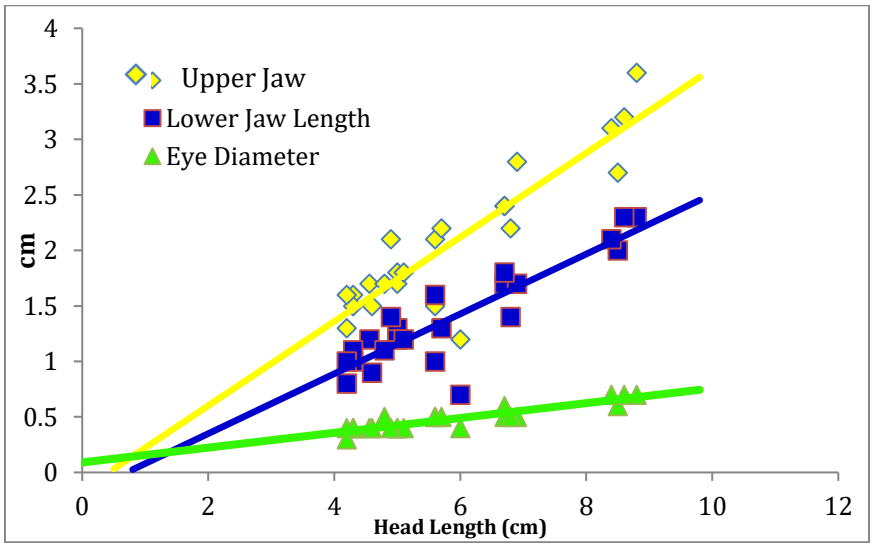

Fig. 6. Graphical representation showing the relationship of UJL, LJL and ED

4. CONCLUSION

The present study on the morphometric characters and meristic counts of *Mastacembelus armatus* (Lacebede, 1800) from Maruthur Anicut, Tirunelveli District concludes that all parameters of the fish grow in accordance with the total length of the fish body as we see a high correlation coefficient, we can say that all characters are controlled based on their size and weight. The conclusion is based on the statistical analysis of the recorded data. Though the morphometric characters are highly correlative, meristic counts have slight variation (± 1 or 2) in a few fishes which may be due to the environmental crisis or genetic alternation (Mutation). These kinds of studies will help in making proper conservation measures for the fish. It also facilitates the easy identification and validation of fish species by measuring and counting the body morphometric and meristic characters. As this fish is edible and partially air breather it is necessary to carry many multi-disciplinary works with this species.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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