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# Describing Sexual Dimorphism in *Mesopristes cancellatus* in Tagoloan River Using Relative Warp Analysis

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**ABSTRACT**

*Sexual dimorphism is the variation in the morphology between individual's sexes that belongs to the same species. Morphological variation in fishes can be attributed to sexual dimorphism. Fish species are known for their large phenotypic plasticity in life-history traits in relation to environmental characteristics. Plasticity allows species to increase their fitness in a given environment. Mesoprites cancellatus is an exceptional species found in Tagoloan River, Misamis Oriental. The primary objective of this study is to describe the variations in the morphology of M. cancellatus so as to determine if sexual dimorphism exists within the species, using relative warp analysis. A total of 3 specimens were sampled, 15 males and 15 females, 130 closely connected points were made on the outline of the body and 50 connected points were made on the caudal fin and were digitized using tpsDig program version 2.12 [5] and subjected into relative warp analysis from where relative warp scores were derived. Thin-plate spline plot, Discriminant Function Analysis and MANOVA showed significant variation in the body shape and caudal fin shape between sexes. However, it is in the body shape that exhibits greater morphological variation compared to the caudal fin shape.*

**Keywords:** Sexual Dimorphism, *Mesopristes cancellatus*, Relative Warp Analysis, Tagoloan River

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## INTRODUCTION

Sexual dimorphism is defined as the variation in the morphology between individual's sexes that belongs to the same species. Sexual dimorphism in shape reflects the effect of sexual selection, ecological differentiation between sexes, or the indirect effects of size dimorphism [14]. Another factor linked to morphological variation is phenotypic plasticity; it is the ability of an organism with a given genotype to change its phenotype in response to abiotic and biotic changes in its habitat [18].

*Mesopristes cancellatus* is a freshwater fish known as tapiroid grunter under class Actinopterygii, order Perciformes, and family Terapontidae. Intraspecific differences in shape observed among freshwater fish populations may reflect heritable or phenotypically plastic traits or some combination of the two [15].

Recent advances in morphometric analytical techniques have provided statistically powerful methods for the analysis of shape [7]. Relative Warp Analysis is one of the geometric morphometric techniques that uses coordinates and allows statistical results to be presented as actual shape or shape deformation and describes shape change as the deformation of landmarks from a refer reference configuration into those of each member in a group of specimens of interest [8]. It allows better comparison of the shapes of different organisms and would no longer rely on word descriptions that usually encounter problems of being interpreted differently by scientist [4].

Hence, the study was conducted to describe the variations in the morphology of *M. cancellatus* so as to determine if sexual dimorphism exists within the species, using relative warp analysis. Information concerning sexual dimorphism is crucial for understanding the ecology, behaviour and life history of a species. By the use of quantitative approach like GM in describing morphological variations, it will be easier to determine relationships between morphology and other variables thus one could make more informed deduction on organism's evolution [3].

## MATERIALS AND METHODS

The sampling station was conducted along the brackishial section of Tagoloan River, Misamis Oriental. The specimen collection of the *M. cancellatus* and water samples was conducted at Sitio Nabulod, Baluarte. The period of data observation and collection were done during the month of November to January 2013. A total of thirty *M. cancellatus* were sampled, 15males and 15females. To reduce the amount of intrapopulation shape variation, only sexually matured specimens were used. The fish samples were then taken images using the digital camera Canon with 12.1 megapixels.

Captured images were checked carefully for an excellent quality that would be used for body shape and caudal fin morphological analysis. The images were then subjected to outline based geometric morphometric analysis. As shown in Figure 1, a total of 130 closely connected points were made along the outline of the body excluding the tail part and 50 connected points were made in the caudal fin in order to capture the general shape using a digitizing program tpsDig version 2.12 [5].

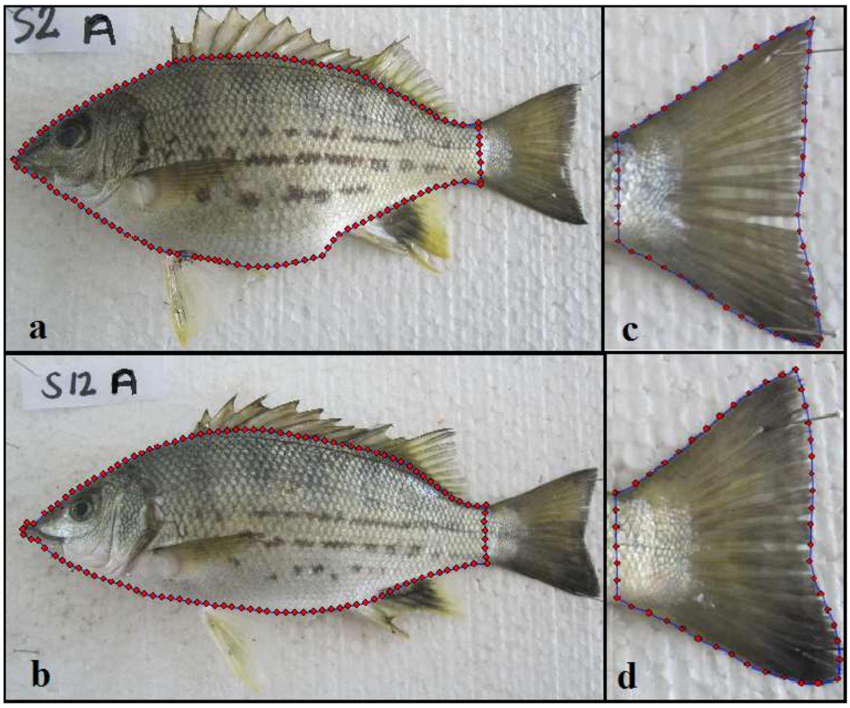


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**Figure1. Digitized image showing the outline points in the body (a=female, b=male) and caudal fin (c=female, d=male) of *M. cancellatus***

The tpsDig was also used to collect the x,y coordinates of each landmarks in the body and caudal fin shape. Relative warp analysis was employed in this study to determine and compare the shape between female and male populations of *M. cancellatus* based on the outline of the body shape and caudal fin shape. Thin-plate spline deformation grids were produced to visualize the difference in the mean shape between male and female *M.*

*cancellatus*. The relative warps analysis and computation of partial-warp scores were done using tpsRelw program, version 1.46 [6]. The relative warp scores were subjected to discriminant function analysis and MANOVA using PAST software version 1.91 [10]. MANOVA was used to determine whether the outline of the body and caudal fin differ significantly between female and male population. Discriminant function analysis was used for confirming or rejecting the hypothesis that two populations are morphologically discrete by classifying each specimen into one of the two groups (female or male) based on the outline of the body and caudal fin.

## RESULTS AND DISCUSSION

The relative warp analysis (RWA) demonstrated variations in the body shape and caudal fin shape between female and male *M. cancellatus.* Relative warps with % variance greater than 5% is considered significance. The 3 significant relative warps jointly accounted for 83.07% of the variation in the body shape between male and female *M. cancellatus*. While in the caudal fin, the 3 significant relative warps collectively accounted for 86.46% of the variation in the body shape between male and female *M. cancellatus*. Figure 2 shows the mean shape of the body and caudal fin of female and male *M. cancellatus*.

From Figure 2, it clearly illustrates that with respect to its abdominal area, female has very contoured abdominal area compared to male. It can also be observed that they differ in the head region; female has broader head shape compared to male which has narrow head shape. Another distinction was observed in the body depth of *M. cancellatus*; female has wider body depth compared to male which has slender body depth.

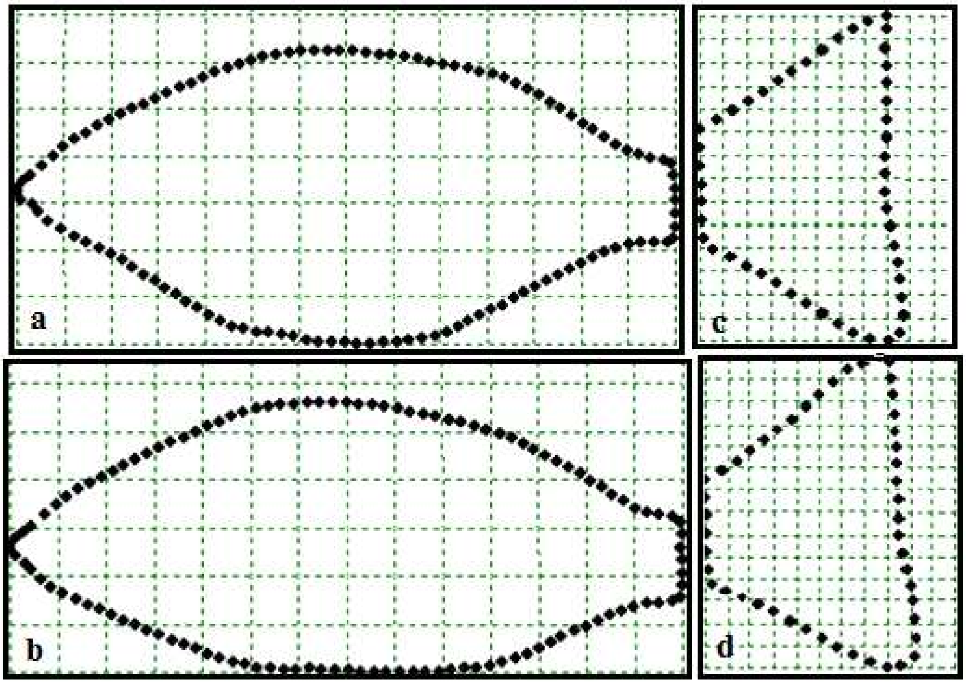


**Figure2. Mean shape of the body (a=female, b=male) and caudal fin (c=female, d=male) of *M. cancellatus*.**

Furthermore, variation in the caudal fin shape between male and female *M. cancellatus* is still evident. With respect to its overall shape; female has slender caudal fin compared to male counterpart; in the upper distal portion of the caudal fin, female has pointed edge compared to male which has rounded one; in terms of the curvature between the upper and lower distal portion of the caudal fin female has more curve side compared to male.

Discriminant analysis supplements the results obtained in the relative warp analysis for the presence of shape variation in *M. cancellatus*. The graphical presentation of the result in this analysis was shown in a form of histogram as shown in Figure 3. The histogram shows the separation between the male and female population represented by two different colours. This indicates the presence of variation in the body shape and the caudal fin shape between male and female *M. cancellatus.* However, morphological variation is not so prominent since there is a presence of overlaps between the two components of the histogram. Body shape exhibit greater degree of morphological variation compared to the caudal fin shape as shown by the distance of separation between the two populations. The farther the populations are from each other, the greater is the morphological variation.

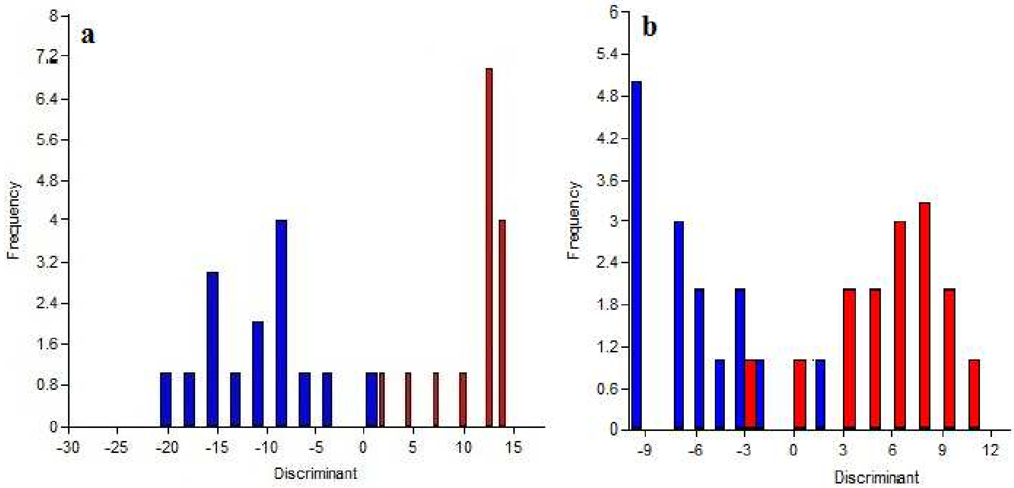


**Figure3. Histogram showing the variation in the (A) body shape and (B) caudal fin shape of the female (red) and male (blue) species of *Mesopristes cancellatus.***

Additionally, although overlapping of components occur between the two populations, morphological variation between male and female population is still evident. This can be explained by the values yielded in the discrimination score table where the percentage of correctly classified items.

If discriminant analysis is effective for a set of data, the reclassification table will yield a high percentage correct. In the given set of data, the result shows that in the body shape of *M. cancellatus*, 96.67% of the male and female were classified correctly. In the caudal fin shape, only 93.33% of the female and male were classified correctly. Male and female population can be discriminated more efficiently using the variation in their body shape compared to the variation in their caudal fin shape. Despite of this discrepancy, it is still safe to say that the degree of shape variation of the body shape and caudal fin shape between male and female *M. cancellatus* is relatively high since the minimum percentage of correctly classified items should be 75% for it to be considered significant.

Multivariate analysis of variance (MANOVA) on relative warp scores also showed significant variation in the body shape and caudal fin shape between female and male population of *M. cancellatus* as shown in Table 3. Based on the p-value, variation in the body shape between male and female population is more significant ($p=9.4633 \times 10^{-08}$) compared to the variation the caudal fin shape (0.00467923).

In relation to the presence of sexual dimorphism within the species of *M. cancellatus* as observed in this study, Darwin was the first to postulate that sexual dimorphism can be explained by sexual selection. This concept predicts that differences in the reproductive roles between sexes may influence patterns of selection and could lead to sex differences in morphological attributes such as the shape of its body. However, sexual dimorphism could also be a functional adaptation for different habits of the two sexes, especially in terms of shape. Exposed to different environmental conditions, fishes, like all organisms are capable of making adaptations to enable them to survive. In fact the environment is recognized as a powerful force in modelling the morphology of an organism during ontogeny. Thus, shape variation between the sexes could also be explained by ecological or niche selection and may be a reflection of the different habitat preference of the two sexes [13].

Webb showed evidence that body shape is a reliable indicator of the swimming behaviour and habitat choice of fishes [12]. Body shape therefore is not only a reflection of genetic character, but also its environment and its habit. Burns made the same suggestion when his wild-caught females of *Poecilia reticulata*, showed smaller heads and deeper caudal peduncles than wild-caught males compared with laboratory-reared specimens which showed no such difference [13]. The above mentioned studies all pointed to habitat difference or habit to explain sexual dimorphism.

Additionally, plasticity in morphometric traits may often be adaptive reflecting the effects of anthropogenic impacts or prey-predator processes in the ecological niches of a population [1]. This phenomenon has been observed by applying geometric morphometrics to the Mediterranean horse mackerel (*Trachurus mediterraneus*) [2], and there are also well-studied examples among the species *Oncorhynchus*.



Other factors that may contribute to shape variation are lifestyle, feeding habits, swimming patterns [14][15] of the fish, rearing temperature of the water [11] and water depth [15]. Above mention, it assumes the water quality might influence in the morphology of *M. cancellatus*, based on the given data it shows that water quality through time changes its characteristics.

## CONCLUSION

Following the series of geometric morphometric analysis and statistical analysis in the morphology of *M. cancellatus*, it was found out that there is a presence of variation in the body shape and caudal fin shape between male and female *M. cancellatus*, signifying the presence of sexual dimorphism within the species. The body shape exhibited greater variation compared to the caudal fin shape. Sexual selection and different habitat preference are some of the factors considered to have influence the presence of sexual dimorphism in *M. Cancellatus.* However, further studies must be conducted to confirm this statement.

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