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THE MORPHOLOGICAL VARIATION IN CULTURED AND WILD POPULATIONS OF *CLARIAS GARIEPINUS* IN SOUTH WEST NIGERIA

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ABSTRACT

The pattern of morphological differentiation among wild and cultured *Clarias gariepinus* from six populations collected in Osun, Owena and Oluwa River (wild) and Akure, Ilesa and Ado-Ekiti (cultured) were examined using morphometrics and meristics index. The first principal component (PC1) accounted for 68% of the total variance in the sampled populations. The second and third and fourth PCs accounted for 14%, 8% and 5% of the total variation respectively. The PC loading analysis revealed that TL and SL accounted for the 68% variation observed in PC1. The loading on PC4 revealed pectoral fin rays and pelvic fin rays to have contributed to 5% variation between populations of *C.gariepinus.*

The first and fourth principal components showed that the observed differences were mainly from total and standard length for morphometric measurements and pelvic and pectoral fin rays of fish, indicating this region to be important in the description of population characteristics. Canonical variate analysis (CVA) plot shows overlapping of clusters of specimens for some of the locations studied.

The study revealed morphological differentiation between wild and cultured *C. gariepinus* from populations.

Keywords: clariidae, canonical variate, principal component, morphometric, meristic

INTRODUCTION

Taxonomy is the pioneering exploration of life on earth, which lays the foundation for the phylogenetic tree of life (Wilson, 2004). It provides requisite database for ecology and conservation science and makes access to the vast and still largely unexplored biodiversity to humanity (Wilson, 2004). Studies involving ichthyo-taxonomy, morphometric characters are generally being used in discriminating many fish species (Teugels, 1992; Anyanwu and Ugwumba, 2003; Eyo, 2002, 2003). They are measurable features which are helpful for separating closely related genera, species and even populations within them (Cadrin, 2000).

Study of morphological variation in wide-ranging species of fishes has in several cases revealed a lack of homogeneity with respect to certain characters (Wimberger, 1992; Turan *et al.*, 2006; Samaradivakara *et al.*, 2012).

The family Clariidae at present consists of 14 genera, which comprise 92 species distributed in Africa and South-East Asia (Teugels, 1986). *Clarias gariepinus* has increasing commercial importance in fisheries and aquaculture. Sound management of fish resources relies on basic knowledge on the biology of the species, including information on population structure. Such information influences the development of management strategies and strategies for conserving biodiversity. Morphological characters such as morphometrics and meristics have been commonly used to identify stocks of fish (Teugels, 1982; Turan, 2004; Turan *et al*., 2004). Virtually little is known about the morphological population structure of *C. gariepinus* in river systems of South West Nigeria compared with hatcheries stocks. In differentiating *C. gariepinus* strains and introgressed hybrids in both cultured environment, it is important to get detailed knowledge on the population structure in wild and farmed *C. gariepinus* and to appropriate such knowledge to the management of the fisheries. Therefore, this study aims at investigating morphological variation in *C. gariepinus* from wild and cultured environment using morphometric and meristic approach in South West Nigeria.

MATERIALS AND METHODS

Samples Collection and Preparation

Two hundred and forty samples of *Clarias gariepinus* of cultured and wild with average weight of 675±1.04g were obtained from six different locations. The cultured samples were obtained from fish farms of Federal University of Technology, Teaching and Research Farm, Akure, Nigeria, Leventis Agricultural Training School, Ilesa, Osun State, Nigeria, Ekiti State Ministry of Agriculture, Ado-Ekiti, Ekiti State, Nigeria, while the wild counterparts were obtained from fishermen at Oluwa River, Agbabu, Ondo State; River Osun, Esa-Odo, Osun State; Owena River, Owena, Ondo State (Fig.1). The fish were kept in six different concrete tanks of $4m^3$ size to acclimatize in Teaching and Research Farm of Federal University of Technology, Akure.

Measurement of morphometric and Meristic characteristics of wild and cultured *Clarias gariespinus*

Morphometric and Meristic characteristics of *Clarias gariepinus* were carried out in the Fisheries and Aquaculture Laboratory, Federal University of Technology, Akure, Nigeria. Morphometric measurements (mm) was taken from each specimen using calibrated measuring board according to Teugels (1982) after anaesthesizing with clove oil using method of Fasakin *et al*., (2009) to demobilize and reduce stress in the fish samples. Measurements were taken from 40 individuals per population. These were standard length (SL), total length (TL) caudal length (CL), head length (HL), body height (BH), caudal peduncle height (CPH), inter-orbital distance (IOD), ocular diameter (OD), pre-anal length (PL), predorsal length (PdL), and head height (HH) were considered. The other characters were the distances between dorsal and pectoral fins (DPD), pectoral and pelvic fins (PPD), pelvic and anal fins (PAD), and dorsal and anal fins (DAnD). Five meristic characters consisting of the dorsal, anal, caudal, pectoral and pelvic fin rays were counted. The fin rays fins were counted with the use of hand lens.

Statistical analysis

Data on morphometric and meristic characters were recorded and subjected to one way Analysis of variance (ANOVA) using SAS 9.2. To illustrate patterns of correlation among populations from various locations, Cluster Analysis was performed on the mophometric and meristic data (Chiu *et al.*, 2002). Also a canonical variate analysis and Student's t-test were employed to observe if populations from various locations were significantly different and to identify morphometric and meristic characters by which these operational taxonomic unit could be diagnosed using

statistical software PAST Version 2.16 (Hammer *et al.,* 2001). Population centroids with 95% confidence ellipses derived from the CVA were used to visualize relationships among populations. In order to illustrate which morphometric characters that differentiate populations, the contribution of variables to the principal components loading (PC) were examined

RESULTS

Univariate statistics (ANOVA) showed that all morphometric measurements were significantly different between samples ($P > 0.05$). It also revealed no statistical differences between males and females for both morphometric and meristics variables ($P < 0.05$) hence, the sexes of fish samples were pooled further analysis.

The principal component analysis (PCA) revealed that the first principal component (PC1) accounted for 68% of the total variance in the sampled populations as shown Table I.

The PC loading analysis revealed that TL and SL accounted for the 68% variation observed in PC1 (Fig.2). The loading on PC4 revealed pectoral fin rays and pelvic fin rays to have contributed to 5% variation between populations of *C. gariepinus* (Fig.3). The second, third and fourth PCs accounted for 14%, 8% and 5% of the total variation respectively. The principal component loading is shown in Figures 2 and 3 respectively. It was shown that total length (TL) and standard length (SL) (Fig.2) has values greater that jolliffe standard of 4.32. Also, pectoral fin and pelvic fin have values greater than jolliffe standard. All other characters in both morphometrics and meristics having values less than 4.32 were considered insignificant.

Figure 4 shows the Canonical variate analysis (CVA) of the morphometric characteristic of *C. gariepinus* from all the locations. The CVA plot shows overlapping of clusters for specimens from Agbabu, Esaodo, Owena and Ado-Ekiti. It revealed that samples from Ilesa and Akure are different from all other locations thus, forming an isolated clusters.

Multivariate analysis of variance (MANOVA) revealed significant differences in body shapes of the six population of *C. gariepinus* as it can be seen based on the distribution of the samples along the first two canonical variate axes (Wilks' lambda = 3.553E-06; Pillai trace = 4.014; P-Value = 1.703E-316). Also from figure 4, the first axis give details of the variation between the populations and accounts for nearly 87.25% of the variance (Eigenvalues for CV1 and CV2 are 208.1 and 15.72, respectively).

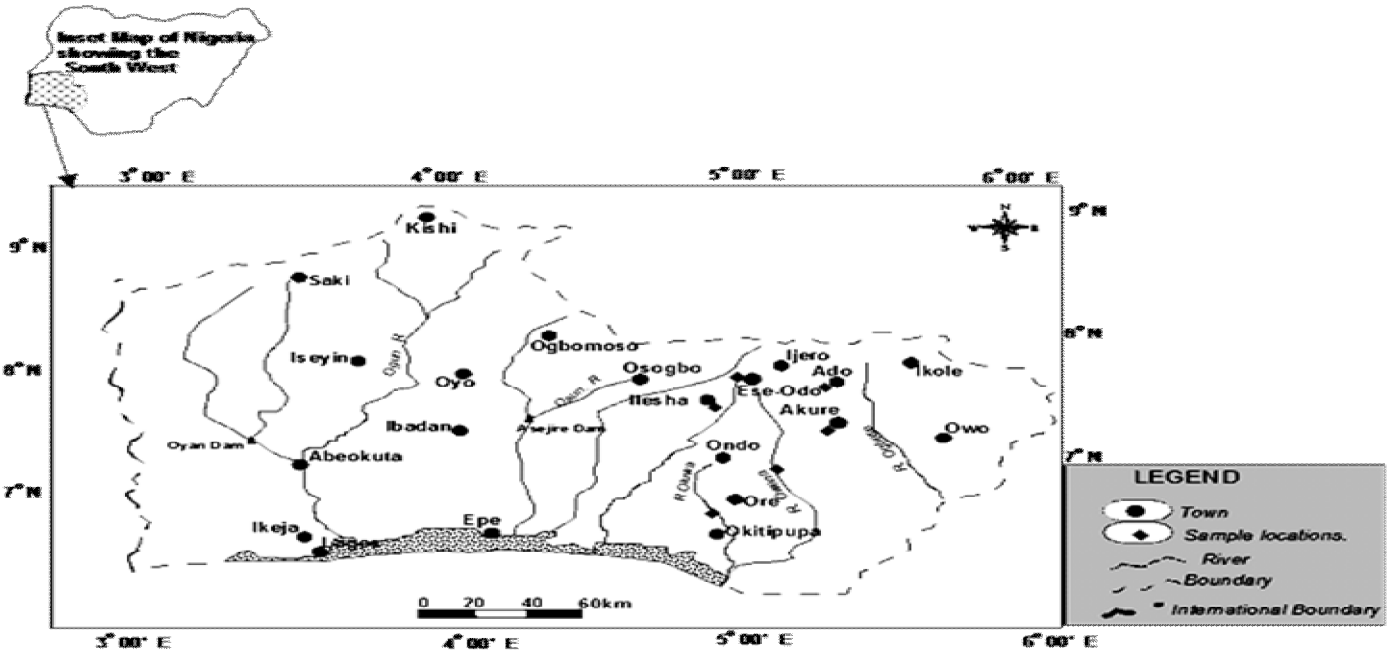

Figure 1: Map of South West Nigeria showing the samples collecting sites

Table 1: Principal Component analysis for the morphological characteristics of C. gariepinus from wild and cultured populations

PC	Eigenvalue	%Variance
1	78.28	68.07
2	16.58	14.42
3	9.20	8.00
4	6.18	5.37
5	1.39	1.21
6	0.78	0.68
7	0.59	0.51
8	0.47	0.41
9	0.29	0.25
10	0.28	0.25
11	0.23	0.20
12	0.21	0.18
13	0.15	0.13
14	0.10	0.09
15	0.09	0.07
16	0.08	0.07
17	0.05	0.04
18	0.04	0.03
19	0.003	0.002

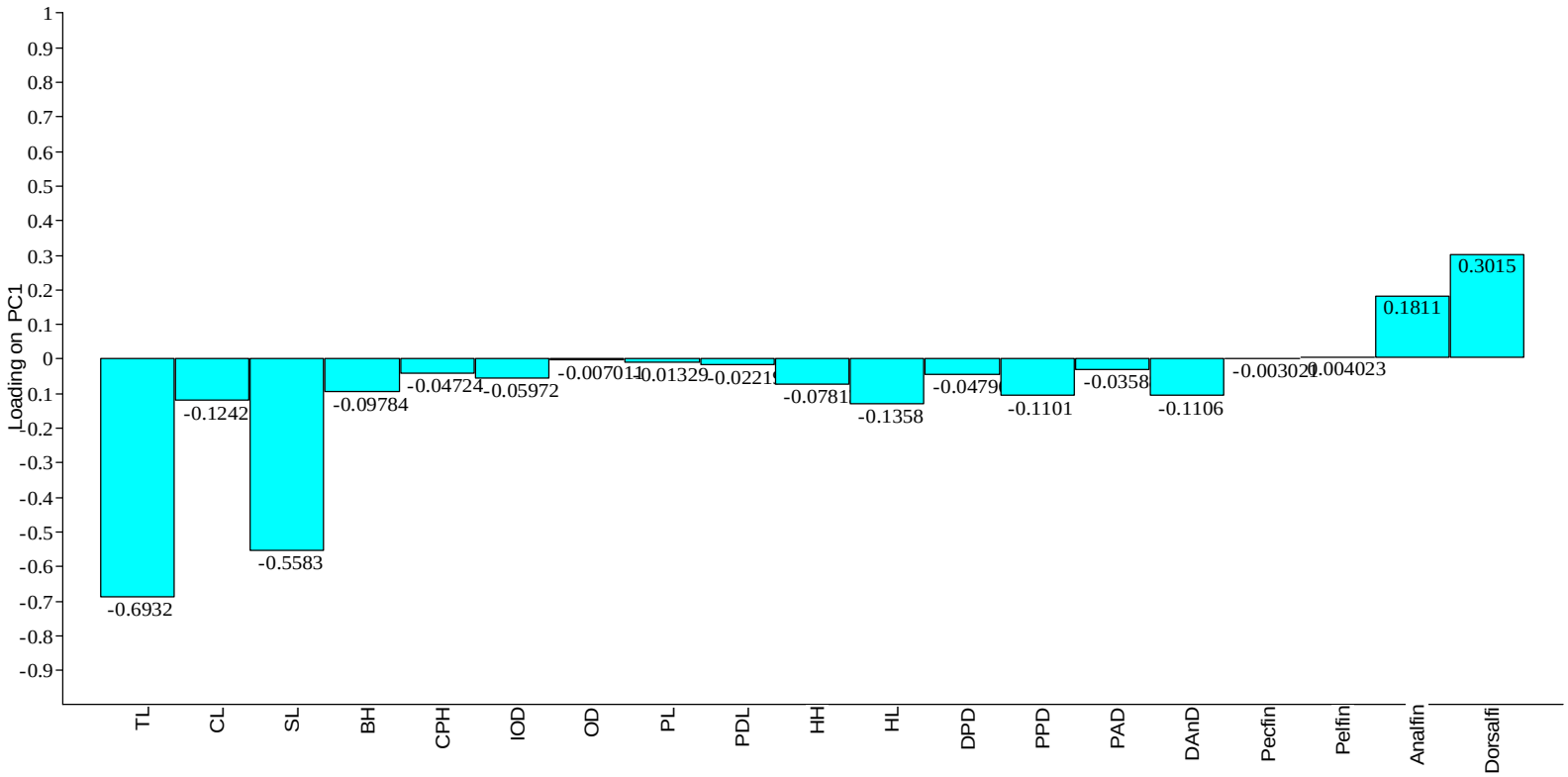

Figure 2: Morphological characteristics of *Clarias gariepinus* from wild and cultured environments and their loadings on PC1 of the principal component analysis

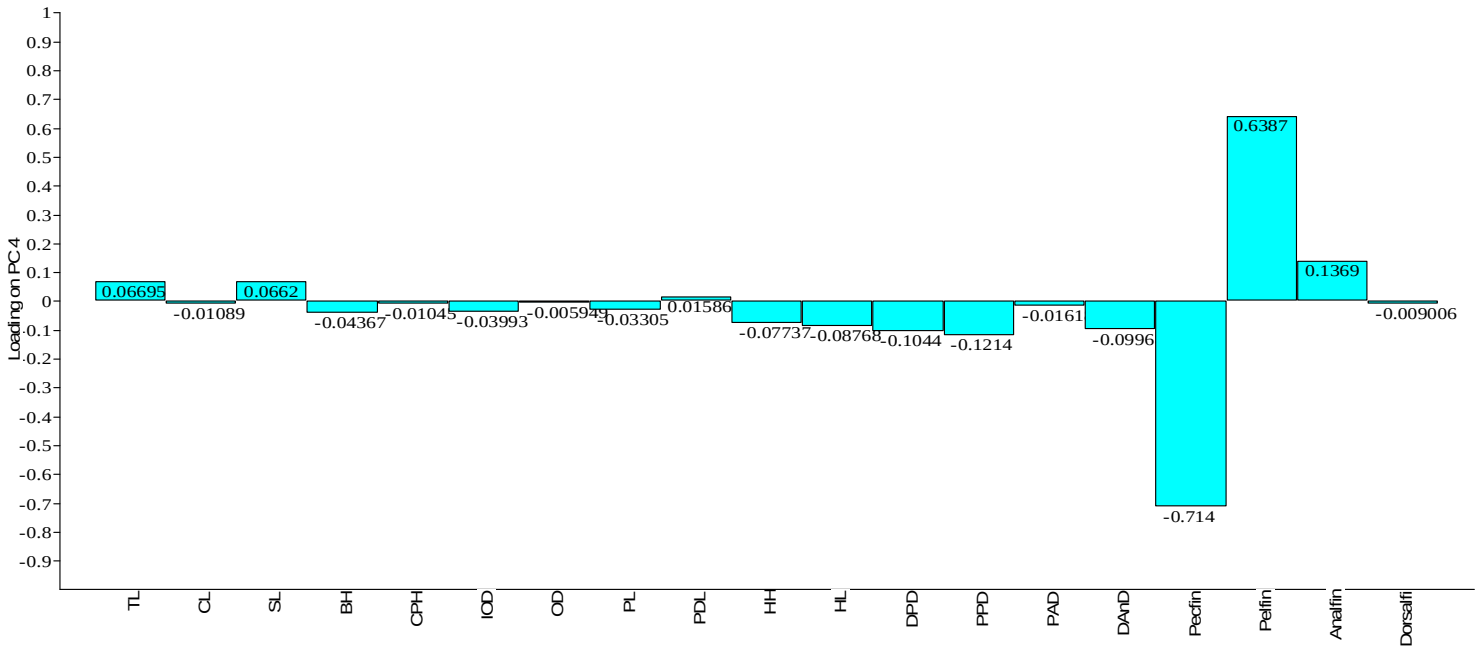

Figure 3: Morphological characteristics of *Clarias gariepinus* from wild and cultured environments and their loadings on PC4 of the principal component analysis

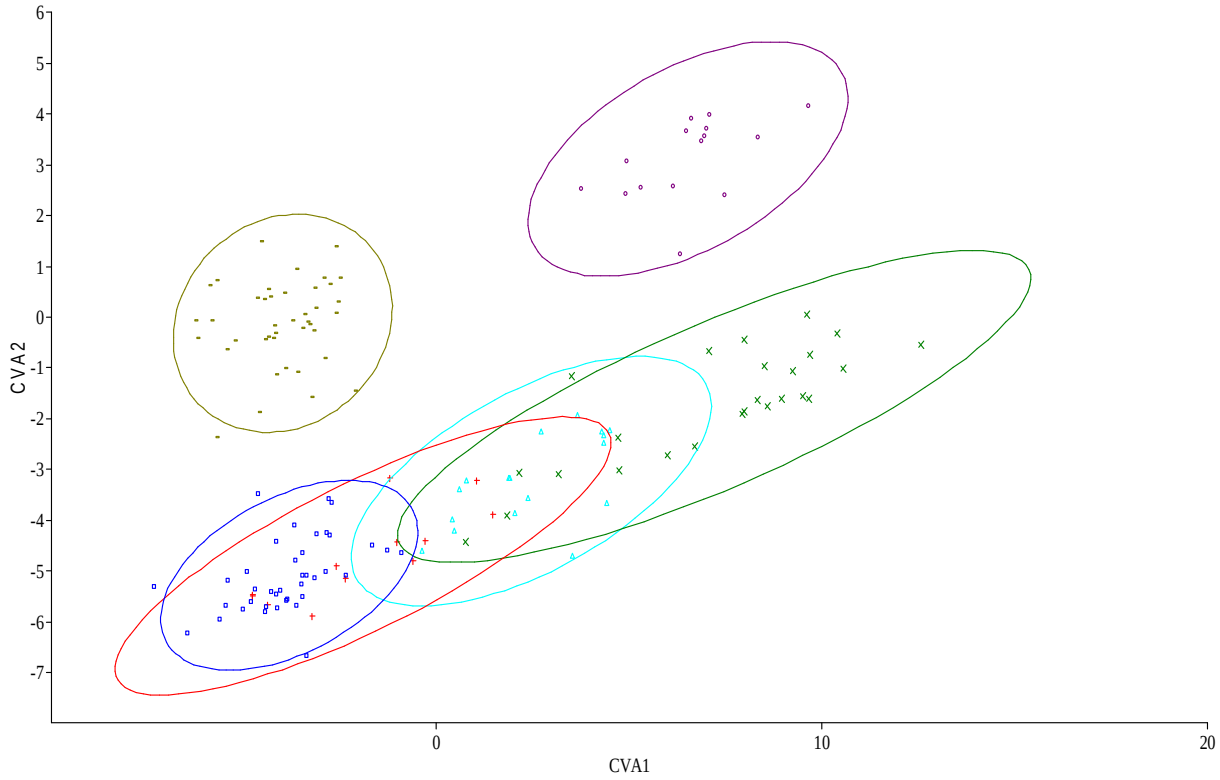

Figure. 4: Canonical variate analysis of morphological characteristics of C. gariepinus from six locations (Ilesa – Akure o Owena x Agbabu + Esaodo ▲ Ado-Ekiti ◘)

DISCUSSION

The present morphometric analysis of the *C. gariepinus* in both wild and cultured populations revealed two considerably distinct populations with varying degrees. PCA revealed that morphometric differentiation between samples was largely located in the total and standard length of *C. gariepinus*.

In this study, both the caudal and head lengths were longer in samples from Owena population, and the eyes were wider than the other samples. Such differences between the populations maybe related to different habitat characteristics, such as temperature, turbidity, food availability, water depth and flow. For instance, eye diameter was greater in the Esaodo and Owena populations; this may be due to differences in turbidity among rivers (Matthews, 1988). This observation could be considered as vertical habitat preference which was reported by Aleev (1969) to have relationship with position of eyes in the head. Also, these features were observed to be shorter in cultured samples. These morphological differentiations could be due to either the selective breeding programmes applied in aquaculture, genetic drift following founding generations, or the different origin of fish used as broodstocks (Karaiskou *et al.*, 2009).

In the CVA scatter plots presented, both Ilesa and Akure populations were isolated and most divergent from the others. It is well known that morphometric characters

can show high plasticity in response to differences in environmental conditions, such as food abundance and temperature (Allendorf, 1988; Swain *et al*., 1991; Wimberger, 1992). Therefore, the distinct environmental structure of the media from the others may cause the detected high morphometric variation of *C. gariepinus*. The populations from Esaodo, Owena Agbabu and Ado-Ekiti points overlap around 0 (zero) of the first and -3.5 of the second axes. The overlapping of the Agbabu, Esaodo, Owena and Ado-Ekiti samples in discriminant space may suggest a sufficient degree of intermingling between these rivers to homogenize populations.

In this study, through CVA, some cultured *C. gariepinus* from Ado-Ekiti were grouped along with wild fish from Agbabu, and Esaodo which probably belong to an escapee group or have ancesrial relationship. Cases in which individuals do not cluster with other samples belonging to the same geographical origin are not surprising, since fingerlings or broodstocks originating from the wild were most likely used to seed hatcheries around Ado-Ekiti or obtained from other sources from neighbouring states. The CVA produces a scatter plot of specimens along the first two canonical axes, producing maximum separation between the six populations of each of the sample evaluated. Thus, the results from MANOVA and visualized by the CVA scatter plots revealed significant differences between populations of *C. gariepinus* based on their body shapes.

The present study revealed morphological differentiation among *C. gariepinus* from wild and cultured populations. The discovered differentiation may be connected to differential environmental conditions such as temperature, turbidity, food availability, and water depth. It was also revealed from the study the evidence of intermingling of cultured *C. gariepinus* samples with the wild samples.

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