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Review

Morphological and genetic variation in *Tilapia guineensis* in West African coastal waters: A mini review

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ABSTRACT

Tilapia guineensis, a typical estuarine cichlid species in the West Coast of Africa, is an important fish species in view of its immense contribution to the need of many African nations in terms of nutrition, growth and development. Knowledge of how genetically diverse and the genetic structure of *T. guineensis* especially with regard to the variation in the genetic constitution of *T. guineensis* populations in this region will be crucial for improving the fish through rational-breeding, proper management, aquaculture production, and stock conservation. Keeping in view the significance of genetic diversity in fish species, report of studies on *T. guineensis* genetic diversity in West Africa was reviewed. Morphological and molecular techniques were used to assess genetic diversity of this species for breeding and conservation purposes. We hereby report the extent and pattern of variation in genetic constitution of *T. guineensis* populations found in some West African countries including Nigeria.

1. Introduction

Tilapia guineensis (Bleeker, 1862) is a euryhaline species that inhabits creeks, lagoons, and other coastal waters of West Africa [1]. It is the third most important lagoon tilapia in this area [2]. It is one of the Cichlid species and an important source of livelihood especially in developing countries such as Nigeria where many people are subsistent farmers [3]. It possesses good aquaculture, economic, and nutritional qualities especially in terms of protein nutrition of West Africans. The contribution of this fish to the development of West African countries including Nigeria can therefore, not be overemphasized. There is, therefore, the need to review the current level of diversity and genetic structure of the present genetic constitution of *T. guineensis* populations present in West Africa including Nigeria. Such knowledge is important for planning genetic conservation strategies towards improving aquaculture potential and availability of fish.

According to Falk et al. [2], for the development, management and conservation strategies, it is very important to assess the current level of population genetic diversity covering a wide geographical range. Consequently, identification of core areas where *T. guineensis* are found and characterization of genetic diversity of fish found in those areas would enhance identification of priority when planning conservation programs.

Morphological variation is a prerequisite for taxonomic identity, population differentiation and genetic diversity assessment for effective management of fisheries resources. Thus, moephometric analysis is usually the first line of approach when investigating the stock structure of species (such as *T. guineensis*) that have large population sizes. Morphometric characters are generally being used in discriminating many fish species in several parts of the world [4], in Africa [5], particularly in Nigeria [6]. However, morphological description alone has proved to be insufficient in determining genetic relationships within and between species [7]. Falk et al. [2], summarized results of some genetic studies on important tilapias including *T. guineensis* found in West African lagoons from various localities in West Africa excluding Nigeria. Genetic diversity of *T. guineensis* in Africa has been assessed using a range of morphological and molecular markers.

In view of the importance of genetic diversity in setting effective national and regional breeding strategic plans and conservation strategies, the present paper reviews previous genetic diversity studies on *T. guineensis* from some West African countries with a recent study from Nigeria [7] with a view to understanding the nature, extent and distribution of genetic variation in *T. guineensis* that exists within and between these

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countries. This would enhance identification of populations with high genetic diversity that could provide useful genetic information and advice on wild genetic resource management, thus improving food security in West African sub-region. This would boost aquaculture production for fish improvement through various genetic and non-genetic conservation strategies.

Preliminary results of studies on *T. guineensis* populations from various localities in West Africa including Nigeria were reviewed. The aim was to analyze available data and reports of studies on some coastal populations of *T. guineensis* in order to stimulate interest and attention on the need to improve this important species and ensure its continuous availability.

2. Morphological variation among *T. guineensis* populations

Morphological characters including morphometric and meristic characters have been widely used to delimit the various populations of *Tilapia guineensis* from Nigerian and other West African countries. Result of morphometric analysis of *T. guineensis* populations in Nigerian coastal waters revealed low morphological differences and clustering into two distinct groups indicating low variability among the populations of *T. guineensis* from the coastal locations studied. This relatedness could be attributed to gene flow that might have existed among the populations thereby preventing significant population differentiation. According to Carvalho [8], if localized populations inhabit similar environments, they may not display great heterogeneity in phenotypic or genetic traits. Another study of *P. monodon* populations from east coast of Indian and Pacific Oceans by Sun et al. [9] reported morphological similarities among the populations. A similar report was made by Thirumaraiselvi et al. [10] in a morphometric study of three populations of Indian Salmon.

The meristic results revealed three clusters instead of two when compared to the morphometric data analysis. This indicates that meristics revealed more variability than morphometrics among the studied populations of *T. guineensis* in Nigeria. Morphological variability among different populations is attributable to differences in genetic structure and environmental conditions. A similar report was made by Simon et al. [11] in two congeneric archer fishes where morphometric characters provided a comperatively less evidence of differentiation. Therefore, animals with the same morphometric characters are often assumed to constitute a stock, and this fact has been used widely in stock differentiation in fisheries industry [12]. This report is in line with the report of Turan et al. [13] who similarly reported three morphological stocks in *Pomatomus saltatrix* in the Black sea. The differences between the populations of *T. guineensis* in Nigeria resulted mainly from the dorsal and caudal fin rays. This agrees with Yakubu and Okunsebor [14] who similarly reported that differences between fish species (*Oreochromis niloticus* and Lates *niloticus*) are from dorsal and caudal fin lengths.

3. Genetic variation among *T. guineensis* populations

Genetic diversity assessment of the *T. guineensis* fish species is essential component in selective breeding and conservation programme in aquaculture fisheries to identify potential parents. Morphological method has some limitations in studying variability among species populations. Microsatellite markers are widely used DNA markers for many purposes including diversity assessment, species identification and genome mapping [15]. The use of these markers to investigate genotypic variations among different populations has been previously reported by some researchers [16,17].

Based on nucleotide diversity estimates from mtDNA, Liberia was taken to be the major center of genetic diversity. The level of genetic diversity in Ivory Coast, Senegal, and Ghana was moderate while Gabon was characterized low genetic diversity. In Nigeria, a total of 28 alleles were revealed which is not comparable with a total of 75 alleles in *O. niloticus* got by Gu et al. [17] suggesting that *T. guineensis* had lower genetic diversity than *O. niloticus.* These results concord with that from other African countries [2]. There is therefore urgent need to prevent further reduction in diversity of *T. guineensis*. This is achievable by introducing various breeding and conservative strategies. Previous study by Ukenye et al. [7] revealed that some Nigerian *T. guineensis* populations found in Badagry, Buguma, and Brass had considerable genetic diversity. There are several measures of genetic diversity however; heterozygosity is recognized as a useful and convenient parameter for assessing genetic diversity [18].

Based on Nei's genetic distance, the genetic diversity between the populations in Nigeria indicated a high genetic similarity and, by implication, a low genetic dissimilarity of 0.30 (Buguma and River Ethiope populations in Rivers and Delta States), thus suggesting a narrow genetic base among the different populations. This implies that these areas should be targeted for conservation programmes as soon as possible. This high genetic similarity may possibly have resulted in high homozygosity that was observed in most of the populations. However, clustering analysis gave four major clusters indicating that some level of genetic variability still exists between some *T. guineensis* populations from Nigeria.

4. Concluding remarks

Using morphological and molecular data to quantify differentiation between populations of *T. guineensis* from coastal locations, some level of variation was observed morphologically and genetically between and among these populations. Analysis of previous reports revealed existence of moderate variation. A study in Nigeria revealed that meristic characters indicated more variability than morphometric attributes in differentiating the morphological stocks of *T. guineensis* in Buguma (Rivers State), Badagry (Lagos State) and Brass (Bayelsa State). These populations have higher genetic diversity compared with other populations with low genetic diversity possibly as a result of higher level of inbreeding in such populations. Information from this mini-review would be of use in justifying and planning a rational breeding and conservation program.

This review has provided significant knowledge on *T. guineensis* population differentiation which would have wide application in utilization and management of genetic resources of *T. guineensis* species. Rivers, Lagos and Bayelsa states of Nigeria show greater genetic and morphological divergence, though there was low level of differentiation between them as indicated by the morphometric report. Although it could be that the variation observed in morphology were significantly correlated with some genetic factors more than environmental factors. However, genetic data collected from the populations slightly support the results of morphological study.

Considering the moderate genetic diversity reported in populations from Senegal, Ivory Coast and Ghana and low genetic diversity values characterized by populations from Gabon, urgent steps are therefore necessary to arrest further reduction in diversity of *T. guineensis* from these populations. Thus, need for developing strategies geared towards conservation and proper management in this region.

Furthermore, it can be deduced that genetic differences may not always be represented by phenotypic variation. This may be due to phenotypic plasticity of fish that allows them to respond adaptively to environmental change [19]. Therefore, it has been highlighted the importance of utility of genetic information in stock differentiation and conservation studies for wild population of *T. guineensis*.

Declaration of Competing Interest

The authors have no conflict of interest to declare.

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