Morphometric Variations in *Sarotherodon melanotheron* (Pisces: Cichlidae) from Brackish and Fresh Water Habitats in South-western Nigeria

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Abstract

A comparative racial study of *Sarotherodon melanotheron* (Ruppell) from brackish and fresh water habitats both in south-western Nigeria using morphometric and meristic characters to determine variations showed that they were phenotypically separable populations of the same species. The results revealed significant differences ($P < 0.05$) in body depth, caudal peduncle depth, number of gill rakers and scales on the lateral line which were suggested to have occurred as a result of difference in the temperature, salinity and substratum in the two water bodies. The results also implied that fresh water broodstock could be preferable to the brackish population for breeding programmes.

Introduction

Sarotherodon melanotheron (Ruppell) is a cichlid that occurs commonly in West Africa and supports a major fishery in the lagoons. This status earns it the common name 'West African lagoon tilapia' (Eyeson, 1979). Pauly (1976) had earlier mentioned the species as a possible candidate for aquaculture. Aspects of its biology and fishery in brackish water of coastal lagoons and estuaries along West Africa have been reported (Fagade & Olaniyan, 1974; Pauly, 1976; Eyeson, 1979, Trewavas, 1982; and Ugwumba, 1988).

However, in Nigeria specimens of *S. melanotheron* were found to have escaped during a high flood of 31 August 1980 from an experimental pond into a small fresh water reservoir in Ibadan, where they have since successfully established themselves. This is Awba reservoir within the University of Ibadan. It is now even suspected that the species may have spread downstream and probably into adjoining fresh water bodies. At this reservoir, Ugwumba & Adebisi (1992), and Ugwumba & Ugwumba (1993) provided information on its food and feeding ecology and biology, respectively. Oyekanmi (2000) studied some morphometric features of the species in relation to limnology of the reservoir. Ugwumba (2002) also reported the diurnal feeding intensity and gut *p*H of the species from Awba reservoir. For this species to have established and thrived well in a fresh water environment for over two decades, there is the need to assess its stock.

The aim of this paper is, therefore, to report on a racial study of *S. melanotheron* using morphometric and meristic characters to determine variations between the Awba reservoir and Lagos lagoon populations in view of possible ecological changes. This study will provide additional information on the species for its farming programme in Nigerian fresh waters.

Materials and methods

Study areas

The study sites are the Awba reservoir in Ibadan and the Lagos lagoon along the coast of Nigeria. Awba reservoir, formed in 1964, is located within the University of Ibadan which lies on latitude 7º 26´ N and longitude 3º 53´ E. The reservoir, with a surface area of about 6 ha and a maximum depth of 5.5 m, is located at an altitude of 185 m above sea level and about 140 km from the coast of Nigeria. The bottom of Awba reservoir was essentially mud with clayey sand in some parts. Many studies on limnological characteristics of the reservoir have been reported (Ita, 1971; Ugwumba, 1990; Omoniyi, 1997; Ugwumba & Ugwumba, 1993; Oyekanmi, 2000).

Lagos lagoon, on the other hand, lies between longitude 3º 23´ and 3º 43´ E and between latitude 6º 22´ and 6º 38´ N. It forms part of an intricate system of waterways made up of lagoons and creeks that are found along the coast of Nigeria from the Republic of Benin border to the Niger Delta. The substratum was fine sand and mixed mud. Some of the physico-chemical features have been described by some authors (Fagade & Olaniyan, 1974; Ikusemiju, 1975; Oyekanmi, 2000). Ajao & Fagade (1990) provided information on its sediments and communities.

Collection of specimens

Samples of *S. melanotheron,* ranging between 120 mm and 150 mm standard length, were collected from both sites within intervals of 1 week in March 2004, to ensure that samples were obtained as close to same period of the year as possible. The size range of fish used were likely to be of approximately the same age. Fishing was done by means of cast nets of 45 and 50 mm mesh sizes. The specimens were transported in ice chest to the laboratory, where measurements started immediately to avoid shrinkage.

Laboratory analysis

Each specimen was given a serial identification number after it was drained off using filter papers. The morphometric features were standard length (SL), head length (HL), head depth (HD), body depth (BD), snout length (Snl), eye diameter (ED), caudal peduncle length (CPL), caudal peduncle depth (CPD) and head to dorsal fin origin (HDO). All measurements were taken with a dial calipers and determined to the nearest millimeter on a measuring board. Measurements of body parts were made with the head of fish pointing left. The meristic characters were dorsal fin rays (DR), pectoral fin rays (PR), ventral fin rays (VR), anal fin rays (AR), branchiostergal rays (BrR), scales on lateral lines (Sc), right and left gill rakers, and vertebrae. All the fin rays were counted with head of fish pointing left.

Counts were made one where two rays had a common root. The branchiostergal rays were also counted on the opercular bone lifting. Scales on both lateral lines were removed using a pair of forceps and counted. The counts on gill rakers were made after removing the brachiostergal arches on both sides as gill rakers on the right and left sides were found to differ in tilapia fish (Omoniyi,1997). Gill rakers on both lower and upper portions of the anterior arch were counted under varying magnifications. Vertebral counts were made after each specimen was oven-dried at 60 ºC for about 18 h. This drying enabled the flesh of the skeleton to be pulled away in each piece on either side without much damage. The count included the atlas while the urostyle was counted as a vertebra. Analysis of the morphometric features was based on a one way analysis of variance (ANOVA) while the chi-squared test of homogeneity was carried out on the meristic counts.

Results

A total of 200 specimens of *S. melano-theron,* made up of 100 each from the two study sites, were examined and analyzed. The statistical analysis of the morphometric features, as shown in Table 1, indicates that there were significant differences ($P < 0.05$) in the body depth (BD) and caudal peduncle depth (CPD) while other features – SL, HL, HD, Snl, ED, CPL and HDO – showed that the fish were, in all probability, obtained from two statistically indistinguishable races or stocks. The mean values of meristic characters from Awba reservoir and Lagos lagoon are shown in Table 2. The fin rays including brachiostergal rays were fairly constant which required no further statistical analysis but other characters such as scales on the lateral lines and gill raker counts revealed significant differences ($P < 0.05$) between the two populations. The vertebral counts showed no appreciable variation between the populations.

TABLE 1

Mean values and F-ratios on morphometric measurements of S. melanotheron *from Awba reservoir and Lagos lagoon*

Morphometric measurements	*Awba reservoir*		*Lagos lagoon*		*F-ratio*
	Range (mm)	*Mean value (mm)*	*Range (mm)*	*Mean value (mm)*	
Standard length (SL)	120.0 – 150.0	134.6 ± 1.46	121.0 – 150.0	134.3 ± 1.17	0.39
Head length (HL)	43.0 – 56.0	46.6 ± 0.24	41.0 – 59.0	45.8 ± 0.18	2.02
Head depth (HD)	19.0 – 26.0	24.2 ± 0.14	18.0 – 24.0	23.1 ± 1.06	2.24
Body depth (BD)	18.0 – 24.0	22.8 ± 0.12	16.0 – 23.0	19.3 ± 0.15	9.65*
Eye diameter (ED)	12.0 – 15.0	13.4 ± 0.13	13.0 – 15.0	13.3 ± 0.11	0.56
Snout length (Snl)	10.0 – 13.0	11.1 ± 0.07	9.0 – 13.0	10.8 ± 0.9	2.03
Caudal peduncle length (CPL)	17.0 – 26.0	22.4 ± 0.38	20.0 – 27.0	22.8 ± 0.41	0.79
Caudal peduncle depth (CPD)	15.0 – 21.0	20.6 ± 0.11	15.0 – 20.0	17.9 ± 0.21	8.27*
Head to dorsal fin origin (HDO)	47.0 – 66.0	52.6 ± 0.42	45.0 – 65.0	52.1 ± 0.35	0.81

Standard error indicated with mean values.

- Effect was significant at 5% level of significance.

TABLE 2
Meristic counts of S. melanotheron *from Awba reservoir and the Lagos lagoon*

Meristic characters	*Awba reservoir*		*Lagos lagoon*		*Chi-square values (X^2)*
	Range	*Mean ± S.E.*	*Range*	*Mean ± S.E.*	
Spinous dorsal fin rays	15 – 17	15.6 ± 0.49	15 – 17	15.5 ± 0.41	Constant values,
Soft dorsal fin rays	10 – 12	10.9 ± 0.41	10 – 13	11.0 ± 0.63	require no further
Pectoral fin rays	12 – 13	12.1 ± 0.22	12 – 14	12.2 ± 0.39	statistical analysis
Ventral fin rays	6	6	6	6	
Branchiostergal rays	4 – 5	4.1 ± 0.05	4 – 5	4.0 ± 0.13	
Anal fin rays	11 – 13	11.8 ± 0.26	12 – 13	12.4 ±0.37	2.53
Scales on lateral lines	28 – 30	29.5 ± 0.31	29 – 32	30.7 ± 0.21	6.75*
Right gill rakers	16 – 20	16.9 ± 0.92	18 – 23	18.8 ± 1.04	12.66*
Left gill rakers	15 – 18	16.3 ± 0.73	18 – 22	18.3 ± 1.06	19.06*
Vertebrae	26 – 28	27.2 ± 0.45	26 – 28	26.9 ± 0.88	0.98

* Shows significant difference. Tabulated value of χ^2 at 5% level of significance = 3.84

Discussion

The objective of a racial study is to establish, with some degree of confidence, the taxonomic identity of a species in differently located bodies of water. This becomes more important in the utilization of its fishery resources because the quality of the existing strain is very crucial for any successful breeding programme. In this study, meristic and morphometric features were used as they still remain dependable tools to characterize fish species especially on the field and they are sensitive to any environmental changes (Fryer & Iles, 1972).

The fairly constant values of fin rays observed in the two populations agree with the findings of Reed *et al.* (1967) and Holden & Reed (1972) that fin rays of the tribe *Tilapiini* do not vary much. The significant variations in BD, CPD, and the number of gill rakers and scales on lateral lines might have occurred as a result of environmental fluctuations, especially water temperature and salinity. The water temperature of Lagos lagoon varied between 24.6 and 31.8 ºC while that of Awba reservoir ranged from 28.0 to 35.8 ºC. Awba reservoir is a fresh water body, whose salinity was less than 0.5‰, and Lagos lagoon has been reported to be brackish whose salinity ranged between 0.5‰ and 15‰ (Ikusemiju, 1975; Ajao & Fagade, 1990).

Huet (1949) found variations in fin rays of the salt water and fresh water races of sticklebacks and concluded that the differences were related to both tempera-ture and salinity. Also, Ikusemiju

(1975) reported that the differences in gill raker counts of *Chrysichthys nigro-digitatus* might have occurred as a result of isolation caused by differences in salinity gradients between Lagos and Lekki lagoons in Nigeria. The nature of substratum, as well as variation in dietary items, have been observed to influence morphometric features of species populations (Marcus, 1986). In this study, the bottom of Awba reservoir was clayey muddy while the substratum of Lagos lagoon was sand mixed with mud. Hence, the significant differences observed in the morphometrics may have occurred as a result of isolation caused by variation in these ecological factors in the two habitats.

With comparable studies from other West African waters (Reed *et al.*, 1967; Holden & Reed, 1972; Omoniyi, 1997), this investi-gation showed that the fresh water population of *S. melanotheron* could be phenotypically separable from the brackish water population which was the original source. Although there was absence of significant variations in many other morphometric features such as SL, HL, HD, ED, HDO and fin ray counts, the observed differences in BD, CPD, and the number of scales and gill rakers could mark the beginning of differentiation between the brackish and fresh water populations of this species. Furthermore, it is suggested that for the farming programme of this species in Nigeria, the brood stock from Awba reservoir should be preferred based on body and caudal peduncle depths data. However, a biochemical analysis needs to be investigated to explain and confirm the genetic basis of the variations before a selective breeding programme of the species is initiated.

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