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Comparative morphometric and meristic characteristics of redbelly tilapia, *Coptodon zillii* (Gervals, 1848) populations from some major water bodies in Nigeria

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Abstract
The morphometric and meristic characteristic of *Coptodon zilli* from five major water bodies in Nigeria were assessed. A total of twenty-nine (29) morphometric measurements and six (6) meristic counts were carried out on two hundred and thirty-nine (239) individual of *coptodon zillii* from Asejire, Oyan, Jebba, Kainji and Geriyo Lakes of Nigeria over a period of 12 months. The data generated were statistically analyzed using analysis of variance (ANOVA) an d multivariate test of discriminant function analysis (DFA). The results showed that all tested characters were significantly different (p<0.05) except dorsal ray,dorsal spine, anal ray, anal spine, upper lateral line scale, lower lateral line scale and right gill raker. *Coptodon zillii* from Asejire Lake were phenotypically seperable population from other populations while there was observed overlapping of characters between Oyan and Jebba Lakes, and Kaniji and Geriyo Lakes. The canonical discriminant plot also revealed a phenotypically seperable populations of *Coptodon zillii* in the studied areas. *Coptodon zillii* from Asejire, Oyan and Kainji Lakes exhibit better characters based on the total weight, total length, body depth and head length data. Based on the result from this study, *Coptodon zillii* from Asejire, Oyan and Kainji Lakes could be a preferred broodstock for breeding and farming programmes.

Keywords: Morphometric measurement, Meristic counts, *Coptodon zilli*, Asejire Lake, Kanji Lake

1. Introduction

Identification of species is a primary step towards any research work and plays a key role for the behavioral study. Morphometric measurements and meristic counts are considered as easiest and authentic methods for the identification of specimen which is termed as morphological systematic [1]. Morphological measurements and meristic counts have been widely used to identify different fish populations [2, 3] and remains the simplest and most direct method of species identification [4]. Hence; it provides useful data for taxonomic status [5]. In general, fish demonstrate greater variances in morphological traits both within and between populations than other vertebrates and are more susceptible to environmentally induced morphological variations. This Morphological plasticity according to environmental variability is commonly found among many fish species, predominantly in freshwater fish species [6]. The cause of variation in the morphometric and meristic characters may range from variability to the intraspecific which is under the influence of environmental parameters [7]. Phenotypic variation according to environmental variability has been widely used by ichthyologists to differentiate among species and among populations within a species [8]. Morphological variability of fish is considered an important adaptive strategy for populations experiencing inconsistent environments [9]

Morphometric variation between stocks can provide a basis for stock structure and may be applicable for studying short-term environmentally induced variation geared towards successful fisheries management and conservation strategies [10, 11]. A number of morphological, physiological, behavioral and biochemical characteristics are used in identification and classification of fishes [12]. It is understood that the analysis of phenotypic variation in morphometric characters or meristic counts is the method most commonly used to delineate stocks of fish. The culture of Tilapia species has gained more ground and has increased immensely in Nigeria in recent times Akinrotimi *et al.* [13] This is so because of its fast growth and the fact that it can easily reproduced in many confined water bodies throughout the country [13]. These tilapia species have highly adapted to a wide range of geographical locations and have shown phenotypic variations after years of introduction and domestication with respect to the pure tilapia strains of the brood stock [14]. This may be as a result of the effects of the environments or due to the hybrids evolved through extensive intra breeding [15]. In this context, natural morphometric and meristic data are of great importance for fisheries management and improvement of aquaculture.

2. Materials and Methods

2.1 Study areas

The study areas include five (5) Lakes among the major Lakes in Nigeria. These include Asejire (07^0 2ˈN, 04^0 07ˈE) and Oyan (7^0 15ˈ N, 3^0 16ˈE) Lakes from the Southwestern Nigeria; Kanji (10°22′N, 4°33′E) and Jebba (9^o 8ˈN, 4^{o}47ˈE) Lakes from the Northcentral of Nigeria and Lake Geriyo (9°8'N,12°25'E) from the Northeastern Nigeria.

2.2 Collection of Sample

Fish samples were collected from the landing sites of the study areas from the fishermen. Freshly collected fish samples were transported to the Laboratory. Taxonomical identification of the specimens was done using the field guide to Nigerian freshwater fish by Olaosebikan and Raji

[16] and freshwater Fishes of Nigeria by Idodo-Umeh [17]. A total of two hundred and thirty-nine (239) individual of coptodon zilli was sampled; fifty-five (55) from Asejire Lake, fifty-one (51) from Oyan lake, forty-nine (49) from Kanji, fifty-two (52) from Jebba lake and thirty nine (39) from Geriyo Lake. Samples were collected between October, 2016 and October, 2017

2.3 Morphometric and meristic Characteristics

Twenty-nine (29) morphological measurements were made on each specimen. Morphometric traits were taken using an absolute digital caliper (Tresna Instruments, 0-150mm range) and all measurements were determined to the nearest millimetre. Measurements were made with the samples facing the left hand side. Body weight was measured using an Ohaun digital weighing balance (Mettler Instrument). The morphometric characteristics measured include the Total Length (TL), Standard Length (SL), Body Depth (BD), Head Length (HL), Snout Length (SnL), Eye diameter (ED) (Left And Right), Dorsal Fin Length (DFL), Anal Fin Length (AFL), Pelvic Fin Length (PvFL) (Left And Right), Pectoral Fin Length (PFL) (Left And Right), Pre orbital Length (PrOL), Caudal Peduncle Length (CPL), Caudal Peduncle Depth (CPD), Pre dorsal Length (PDL), Pre Anal Length (PAL), Lower Lip Width (LLW), Lower Jaw Width (LJW), Pelvic Distance (PD), Cheek Distance (CD), Lower Lip Length (LLL), Upper Lip Length (ULL), Pelvic Spine Length (PSL) (Left And Right), Last Dorsal Spine (LDS), Third Anal Spine (TAS).

Six (6) meristic characteristics that were made include Dorsal Spine (DS), Dorsal Ray (DR), Anal Spine (AP), Anal Ray (AR), Lateral-Line Scale (LLS), and Gill Raker (GR) (Left and Right).

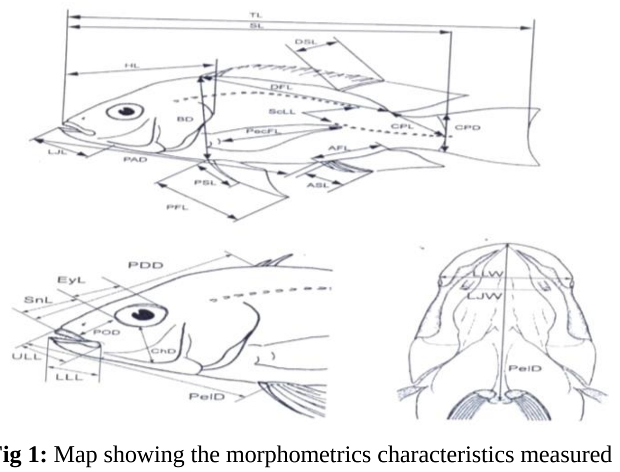

Fig 1: Map showing the morphometrics characteristics measured

2.4 Statistical Analysis

All data were normalized by size-adjustment before subjection to statistical analysis. The standardized data were analyzed by univariate and multivariate methods. Differences among sampled populations were tested by one-way analysis of variance (ANOVA). Multivariate test of discriminant function analysis were performed to identify characters that were important in distinguishing the population groups

3. Results

The mean body weight of *Coptodon zillii* ranges from 22.93±6.95 in Geriyo lake to 125.39±17.03 in Asejire Lake (Table 1). The mean body weight of *Coptodon zillii* from Asejire Lake is significantly different (P<0.05) from other Lakes while that of Oyan and Jebba Lakes are not significantly different and likewise Kainji and Geriyo Lakes. The mean total length of the fish ranges from 107.73±11.97 in Geriyo Lake to 179.39±9.84 in Asejire. The mean total length of the fish from Asejire lake is significantly different from other lakes while that of Oyan and Jebba Lakes are not significantly different and likewise Kainji and Geriyo Lakes. Virtually, all the morphomeristic data were significantly different (P<0.05) among the lakes except the dorsal ray (DR), dorsal spine (DS), Anal spine (AS), anal ray (AR), upper lateral line scale (ULLS), lower lateral line scale (LLLS) and left gill raker (GRL) that were not significantly different. However, there is overlapping of some characters between the *Coptodon zilli*i from Oyan and Jebba Lakes and also from Kainji and Geriyo Lakes

The canonical discriminant plot for *Coptodon zilli*i from the five (5) lakes is presented in Figure 2 as it was extracted from the canonical discriminant function coefficient (Table 2). It showed that the first discriminant function (DF_1) which provided the highest intra-variations between the indices had high positive loadings for anal fin length (AFL) (0.982) followed by gill raker right (GRR) (0.758) with the highest negative loading for Upper lip length (ULL) (-1.488). The second discriminant function showed highest positive loading for anal spine (AS) (0.913) and the third anal spine (TAS) (0.821). It may be inferred that sites that occupy the second (Oyan lake) and fourth quadrants (Asejire lake) of the plot had higher positive loading for anal fin length and right gill raker count while the first (Jebba lake) and third quadrants (Geriyo lake) had lower positive loading for anal fin length and right gill raker counts depending on their polarity in the plot. *C. zillii* from Kainji had an average positive loading for anal fin length and right gill rakers count as showed in Figure 2.

Table 1: Mean values of the morphomeristics of Coptodon zilli from selected water bodies

	Asejire	**Oyan**	**Kanji**	**Jebba**	**Geriyo**
Characters	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Total Weight (g)	125.39±17.03 ᵃ	70.20±24.57ᵇ	24.81±15.98ᶜ	61.43±34.40ᵇ	22.93±6.95ᶜ
Total Length (cm)	179.39±9.84 ᵃ	149.07±17.17 ᵇ	107.77±19.62ᶜ	139.23±26.44ᵇ	107.73±11.97ᶜ
Standard Length	141.42±6.57 ᵃ	116.98±14.55 ᵇ	84.54±15.95ᶜ	111.57±21.25ᵇ	83.31±9.39ᶜ
Body Depth	64.833.19 ᵃ	51.78±7.18 ᵇ	34.31±6.16ᵈ	46.19±10.07ᶜ	35.26±3.99ᵈ
Head Length	44.62±2.14 ᵃ	37.45±4.50 ᵇ	27.99±4.92ᶜ	36.87±6.31ᵇ	27.97±2.79ᶜ
Snout Length	18.84±2.17 ᵃ	15.55±2.21ᵃᵇ	10.03±2.37ᵇ	14.77±22.22ᵃᵇ	9.71±1.09ᵇ
Eye Diameter L	11.38±0.53 ᵃ	9.85±0.97 ᵇ	8.28±1.10ᶜ	9.45±1.17ᵇ	7.64±0.84ᶜ
Eye Diameter R	11.50±0.45 ᵃ	10.06±0.93 ᵇ	8.31±0.99ᵈ	9.38±1.20ᶜ	7.66±0.77ᵉ
Dorsal Fin Length	87.02±4.66 ᵃ	69.13±9.28 ᵇ	48.79±9.34ᶜ	64.74±12.08ᵇ	47.69±5.25ᶜ
Anal Fin Length	28.32±1.84 ᵃ	21.60±2.68ᵇᶜ	15.07±2.75ᵈ	20.45±3.92ᶜ	14.78±2.06ᵈ
Pelvic Fin L L	46.12±3.67 ᵃ	37.20±5.53 ᵇ	25.00±5.27ᵈ	32.75±6.61ᶜ	26.49±2.29ᵈ

Pelvic Fin L R	45.38±3.93 a	37.21±5.09 b	25.27±5.14d	33.61±6.17c	26.13±3.24d
Pect.Fin L	52.45±3.19 a	43.94±7.46 b	26.67±4.38d	35.33±9.00c	28.84±4.48d
Preorbital L	12.57±1.78a	9.10±1.41 b	5.64±1.41c	8.14±1.77b	5.49±0.83c
Caudal Peduncle L	19.45±1.35 a	17.52±3.66 b	11.28±2.58d	15.25±2.73c	11.99±2.29d
Pre dorsal Length	53.02±2.50 a	43.88±5.82 b	30.33±5.18 c	40.13±7.59b	30.68±3.20c
Pre anal Length	104.11±4.90 a	86.49±11.42 b	61.40±11.25 c	82.18±15.90b	59.76±6.85c
Lower Lip Width	12.64±1.07 a	11.64±2.09a	7.93±2.34 c	11.74±2.51a	9.13±1.27b
Lower Jaw Width	11.48±0.98 a	10.40±1.70ab	6.67±2.10c	9.93±2.25b	7.18±1.04c
Pelvic Distance	58.20±2.44 a	47.84±6.39 b	35.98±6.85b	47.89±8.07b	35.94±3.75b
Cheek Distance	17.43±0.97 a	14.76±2.17 b	9.69±2.24c	13.86±3.06b	9.89±1.22c
Lower Lip Length	8.65±0.95 a	7.80±1.23a	6.06±1.40b	8.03±1.66a	6.63±0.98b
Upper Lip Length	9.78±0.83 ab	9.56±1.50ab	7.84±1.95b	10.71±2.37a	8.05±0.89b
Caudal Peduncle Depth	22.91±1.72 a	19.42±2.65 ab	12.38±2.45c	16.36±3.69bc	12.53±1.51c
Pect. Spine L L	25.47±1.94 a	20.60±2.61 b	14.16±2.96c	16.65±2.89c	12.55±1.26d
Pect. Spine L R	25.61±1.85a	20.27±2.78 b	13.95±2.69c	17.42±3.00b	12.70±1.30c
Last Dorsal Spine	25.30±1.83 a	20.76±3.28 b	13.90±2.42c	18.53±3.28b	13.33±1.56c
Third Anal Spine	19.97±1.49a	18.06±2.49a	12.10±2.10c	15.50±2.16b	12.23±1.07c
Dorsal Spine	15.75±0.44 a	15.35±0.49 a	15.32±0.48a	15.14±0.48a	15.17±0.58a
Dorsal Ray	12.25±0.85a	12.95±0.22a	11.32±0.58a	11.57±0.51a	12.17±0.58a
Anal Spine	3.00±0.00a	3.00±0.00a	3.00±0.00a	3.00±0.00a	3.00±0.00a
Anal Ray	9.15±0.59a	9.35±0.59a	8.05±0.23a	8.33±0.48c	9.00±0.43a
Upper Lateral Line Sc.	20.75±0.44da	20.65±0.49a	21.11±0.32a	21.05±0.38a	21.08±0.29a
Lower Lateral Line Sc.	13.50±0.95 a	12.95±2.86a	12.37±0.50a	11.05±0.74a	12.08±2.94a
Gill Raker Left	9.80±0.41 a	9.90±0.45a	8.11±0.32 a	8.05±0.22a	9.08±0.51a
Gill Raker Right	10.00±0.32a	9.90±0.45ab	8.16±0.37b	8.14±0.36b	9.08±0.29ab

Data on the same row with same superscript are not significantly different ($p<0.05$)

Table 2: Standardized Canonical Discriminant function Coefficient of variables from *Coptodon zillii* from the studied sites

	Functions			
	1	2	3	4
AFL	0.982	-0.047	0.135	0.947
ULL	-1.488	-0.194	1.003	0.201
PcSL_right	0.435	-0.351	-1.791	0.381
TAS	0.327	0.821	0.412	-1.271
GR_right	0.758	0.122	0.441	0.068

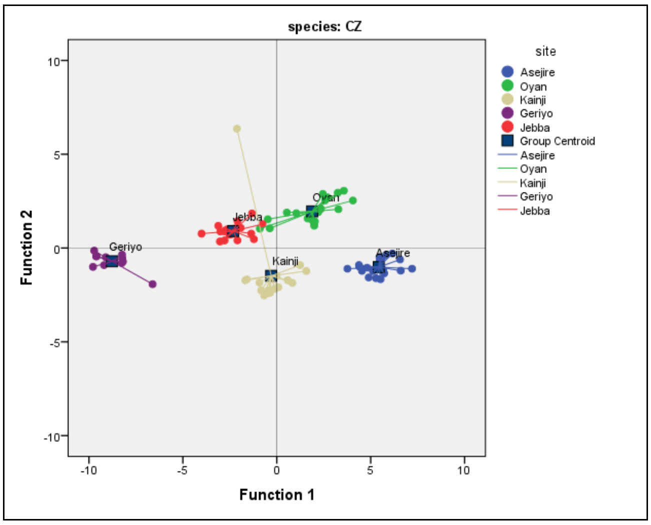

Fig 1: Canonical discriminant plot for *Coptodon zilli*i from the studied sites

4. Discussion

The basic objective of any racial study is to establish the taxonomical identity of a species inhabiting different water bodies at a given time. This racial study becomes highly paramount in the successful utilization of the fisheries resources as the successful breeding programme of any fish species depend on the quality of the existing strain. In this present study, morphometric and meristic characteristics were used since they still remain dependable tools to characterize fish species especially on the field [18].

The observed significant variations in most of the morphometric and meristic characters is similar to report of Oyewunmi *et al.* [19] who reported a significant variation in the eye diameter, dorsal fin ray, caudal peduncle depth and left gill raker of *Sarotherodon galileaus* from three man-made lakes. Akinrotimi *et al.* [13] also reported body depth and caudal peduncle length as the discriminating characters in *Sarotherodon melanotheron* from three different Creeks in River State. The head length, body depth, and caudal peduncle width are reported by Ezeafulukwe *et al.* [6] to be discriminating characters between *Coptodon zilli* from the wild and that of the ponds. Although, different results were observed by Fagbuaro [20] who reported the head length, total length, body weight, standard length and pre-pelvic distance as the discriminating characters in *Coptodon zilli* from three major dams in Southwestern Nigeria. The overlapping of some characters between the *Coptodon zillii* from Kainji and Geriyo lakes could be associated to the fact that both lakes are in the ecological zones and experience almost the same environmental conditions. The overlapping of some characters in species from Oyan and Jebba lakes could not be explained other than their genetical relatedness as both lakes are in different ecological zones and hence, experience different environmental conditions.

However, discriminant function analysis indicated the right gill raker as the only distinguishing meristic character among the *Coptodon zilli* population as shown by the discriminant function analysis (DFA). Similar conclusion was made by Oyewunmi *et al.* [19] who also reported the right gill raker as the only distinguishing meristic character that separate *S. galileaus* from three man-made lakes. Although, Ezeafulukwe *et al*. [6] and Fagbuaro [20] reported no significance difference in the gill raker of *coptodon zillii* and Akinrotimi *et al.* [13] in the gill raker *Sarotherodon melanotheron* compared to the right gill rakers observed in the present study.

The fair constant values of fin rays observed in the *Coptodon zillii* in the five [5] lakes agree with the findings of Reed *et al.* [21] that fin rays of the tilapiini do not vary much. The report of Akinrotimi *et al*. [13] and Fagbuaro [20] on fin rays of the tilapiine tribe also followed the same pattern. In this present study, the values of head length varied significantly between the fish sampled from Asejire Lake and other lakes. This observation agree with the findings of Turan *et al*. [22] who reported that differences between populations of Tilapiine species were reflected mostly in head measurement. The morphometric and meristic variations observed in the present study could be as a result of environment fluctuations especially water temperature [13] Environmental conditions such as food abundance and temperature have also been highlighted to causes high morphological plasticity in fish [9, 23]. Meanwhile, Pakkasmaa and Piironen [24] suggested that genetic differences and reproductive isolation between populations may result to local adaptation, which will invariably reflect in morphology, behaviour, physiology and life history traits. The inbreeding, crossbreeding and other practices that can dilute gene pool has been elaborated by Solomon *et al*. [25] as the major cause of genetic variations which resulted in the differences in cultured and wild African catfish. However, the marked differences of morphology in the present study may be as a result of environmental, ecological and genetical differences of the species as a result of differences in the natural stock [19, 13]. Beacham [26] also stated that the variation among populations of fish characters could be induced by ecological factors interacted with fundamental genetic roles.

5. Conclusion

In this study, morphometric and meristics characteristics were used to characterize *Coptodon zillii*. The values of fin rays in *Coptodon zillii* were constant in all the five [5] lakes. The observed variations might have occurred as a result of environmental fluctuations and genetical differences. It is therefore suggested that *Coptodon zillii* from Asejire, Oyan and Kainji lakes could be a preferred broodstock for breeding and farming programmes as they exhibit better characters based on the total weight, total length, body depth and head length data.

6. Acknowledgment

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7. References

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