Adamawa State University Journal of Scientific Research
ISSN: 2251-0702 (P)
Volume 6 Number 2, August, 2018; Article no. ADSUJSR 0602020
http://www.adsujsr.com

Morphometric measurements and meristic counts of *Chrysichthys nigrodigitatus* (Lacèpède, 1803) from two ecological zones in Nigeria

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Abstract

This study reports the Morphometric measurements and meristic counts of *Chrysichthys nigrodigitatus* from two ecological zones in Nigeria that could be used to discriminate *Chrysichthys nigrodigitatus* from samples collected in Kainji and Asejire dams. Forty fish samples were used to determine the morphometric measurement and meristic counts. The morphometric characters were presented using principal component analysis (PCA) to show relationship and differences between the two water bodies and all the samples from Asejire were almost imbedded in that of Kainji due to the size of the fish samples collected and the most likely difference could be likely attributed to availability of another species of *Chrysichthys* in the Asejire dam or environmental factors. The meristic counts were similar with the exception of anal fin rays which revealed 13 in some samples collected from Asejire dam while that of Kainji dam did not exceed 12, this could be used to discriminate *Chrysichthys nigrodigitatus* from the two water bodies. *Chrysichthys nigrodigitatus* from Kainji and Asejire dam are not similar morphologically which means that morphological variations can be used as a mean of differentiating *Chrysichthys nigrodigitatus* from Kainji dam and Asejire dam, Likewise Meristic count also differ with the anal fin rays count. Therefore external features can be used to differentiate *Chrysichthys nigrodigitatus* from the two ecology zones.

Keywords: Morphometric measurements; meristic counts; *Chrysichthys nigrodigitatus*; principal component analysis (PCA).

Introduction

The genus *Chrysichthys* belongs to the family Bagridae and has been described by Reed *et al.*, (1967), and Idodo-Umeh (2003). The genus exhibits great economic importance and several aspects of its biology have been studied by various authors in Nigerian water bodies: age and growth (Fagade 1980a, Fagade 1980b, Ezenwa and Ikusemiju 1981), condition factor, diet and reproductive biology (Ikusemiju and Olaniyan 1977, Nwadiaro and Okorie 1987, Ajah *et al.* 2006, Oso *et al.* 2006, Offem *et al.* 2008, Yem *et al.* 2009, Atobatele and Ugwumba 2011) and diseases (Obiekezie *et al*. 1988). Morphometric studies on Nigerian fishes have been carried out to assess specific variation (Anyanwu and Ugwumba 2002, Adedeji and Araoye 2006) and congeneric variation (Anyanwu and Ugwumba 2003, Eyo 2003). Anyanwu and Ugwumba (2002) demonstrated that variations in morphometric characters of a species from different localities are attributed to environmental factors. It can also be attributed to the growth rate (Adedeji and Araoye 2006) which in turn could depend on their genotype, availability of food and rate of reproduction (Anyanwu and Ugwumba 2003). Atobatele and Ugwumba (2011) reported that intensive fishing activity has impacted negatively on fish size as they are not allowed to grow to maximum size. These small sized fish species are difficult to differentiate externally except by meristic counts.

In recent years, attempts have been made to relate other morphological characteristic of fishes such as mouth (karpouzi and Stergiou, 2003, Karachle and Stergiou, 2011), intestine (Kramer and Bruant 1995, Karachle and Stergiou, 2010) and tail to total length, and as well as to feeding habits and fractional trophic levels. Generally, eco-morphological studies focus on the patterns that relate morphology and use of available resources (Motta *et al*, 1995, Wain wright and Richard, 1995), as they consider morphology as a key factor for the determination of a species feeding habits. Variations in morphology are due to differences in the ability of different fish species to catch and consume their food, affecting the overall diet composition (Wain wright and Richard 1995, Wootton 1995). Mouth gap has long being

considered as the most important, yet restraining factor affecting food consumption mainly in defining the size range of prey items a consumer can catch/consume and affecting the efficiency of a predator to catch and consume its food (Wain wright and Richard, 1995). More specially, mouth gap can be used for the evaluation of the relationship between prey and predator size (Keast and Webb, 1996, Wain wright and Richard, 1995), whereas mouth shape end position teeth, structure and number of gillrakers seem to be related to the type of food being consumed (Kapoor *et al*., 1975).

Meristics is an area of ichthyology which relates to counting quantitative features of fish, such as the number of fins or scales. A meristic (countable trait) can be used to describe a particular species of fish, or used to identify an unknown species. Meristic traits are often described in a shorthand notation called a meristic formula. Meristic characters are the countable structures occurring in series (e.g. myomeres, vertebrae, fin rays) in fish. These characters are among the characters most commonly used for differentiation of species and populations. In the salmonids, scale counts have been most widely used for the differentiation of populations within species. In rainbow and steelhead trout the most notable differences among populations occur in counts of scales. Meristic characters are used in many other fields, such as in botany or in zoology. Meristic comparison is used in phenetic and cladistic analysis.

Materials and Methods

Sample collection

A total of forty adult fish specimens ranging from 15.00 to 36.40cm and 21.88 to 308.84g in total length and body weight respectively were collected from Kainji and Asejire dams to determine morphometric measurements and meristic counts in May and June 2016 with the assistance of local fishermen using gill nets. Specimens were procured from daily catch of fishermen using planked canoes at landing points, all the fish specimens were kept in the iceboxes and taken to the Fish Technology Laboratory of the Federal College of Freshwater Fisheries Technology (FCFFT), New-Bussa for the morphometric measurement and meristic count, the specimens were weighed fresh using a digital balance (Adam Model AAA 250L) to the nearest 0.01g. All measurements were taken on the left side of the fish using a measuring board, twine, dial reading calipers and measuring rulers to the nearest cm. The characters determined are shown in Figure 1 For the morphometric measurements, Fifteen (15) measureable characters were used for this study that is, total length, standard length, body weight, body depth/height, others are head length, snout length, eye diameter, length of caudal peduncle, pre anal length, length of pelvic fin, length of pectoral fin, depth of caudal peduncle, length of the dorsal fin base, length of anal fin base, pre dorsal fin length. Twine, measuring ruler, pair of dividers, sensitive weighing balance and dial reading calipers were used for the measurement, the twine were placed on the part of the fish to be measured. Twine were used to measure all the lengths, the lengths measured by the twine were placed on the measuring ruler. Twine were initially used before placing on measuring ruler because the ruler cannot bend along the shape of the fish. Similarly, pair of dividers were placed on the fish eye orbit to measure the eye diameter as well as the depth of the fish, the distance between the pair of the dividers were placed on the measuring ruler to read the metres, for accuracy dial reading calipers were also used to confirm the readings, fish samples were placed on the sensitive weighing balance to read the fish weight. Fish samples were morphologically identified using taxonomic keys described by (Olaosebikan and Raji, 2001).

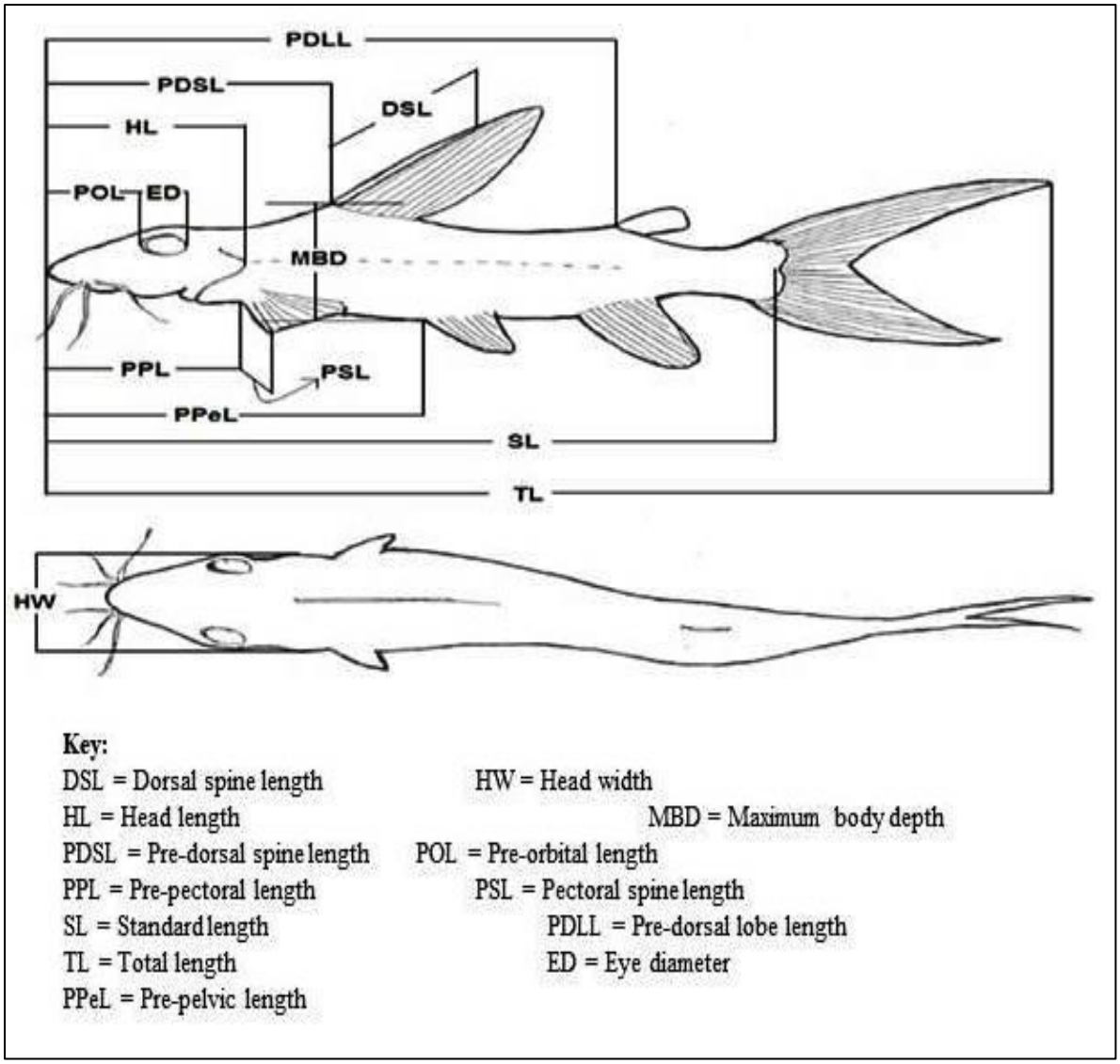


Figure 1 Morphometric Variables Measured for *Chrysichthys nigrodigitatus* from Kainji and Asejire Dams, Nigeria. Oluwatosin E.A. (2013)

Statistical analysis

Data was analyzed for means, standard error of means, and analysis of variance using Microsoft Excel 2007 Descriptive and inferential statistics were performed to ravel the relationship between the measured variables using principal component analysis (PCA)

Results

Morphometric Measurement of Chrysichthys nigrodigitatus

The comparison of the morphometric parameters of fish between Asejire and Kainji dams were presented in table 1. The table depicts morphometric measurement of *Chrysichthys nigrodigitatus* from Kainji and Asejire dams, there were significant difference ($p<0.05$) in the following parameters measured. The body weight from Kainji dam was high (151.69g) while that of Asejire dam was low (64.17g), likewise total length from Kainji dam was high (26.58g) while that of Asejire dam was low (22.21g), similarly standard length was also high from Kainji dam (18.85g) while that of Asejire dam was low (15.63g). In addition, body depth, snout length and pre anal fin length were all higher from Kainji dam (3.99, 2.00g, 13.59g) than (3.16g, 1.54g, 11.27g) from Asejire dam respectively.

Table 1: The Range and the Mean Values (S.D) of *Chrysichthys nigrodigitatus* from the Morphometric Measurement of Kainji and Asejire dams

	KAINJI		ASEJIRE	
PARAMETERS	**RANGE**	**MEAN**	**RANGE**	**MEAN**
Body weight (g)	21.88-308.84	151.69 ± 96.16[b]	40.29-96.25	64.168 ± 17.47[a]
Total length (cm)	15.00-36.40	26.58± 7.42[b]	19.00-25.20	22.21±1.93[a]
Standard length (cm)	10.50-26.50	18.85 ±5.20[b]	13.00-18.00	15.63±1.33[a]
Body depth (cm)	2.00-6.5.00	3.99±5.20[b]	2.70-3.70	3.16±0.26[a]
Head length (cm)	2.70-7.70	5.25±1.44	4.00-5.40	4.7±0.33
Snout length (cm)	1.00-3.30	2.00±0.63[b]	1.20-1.90	1.54±0.23[a]
Eye diameter(cm)	1.00-1.70	1.28±0.25	1.00 - 120	1.19±0.05
Pre dorsal fin length (cm)	4.00 - 11.00	7.03±2.04	5.20 - 7.10	6.17±0.55
Pre anal fin length (cm)	7.00 - 19.30	13.59±3.78[b]	9.7-12.5	11.27±0.55[a]
Length of the dorsal fin base (cm)	1.20 - 3.50	2.23 ± 0.70	1.80 -2.50	2.2±0.21
Length of the anal fin base (cm)	1.00-3.47	2.21±0.73	1.50-2.30	1.84±0.26
Pectoral fin length (cm)	2.10-5.20	3.47±0.97	2.10-3.20	2.75±0.37
Pelvic fin length (cm)	2.10-5.20	3.47±0.97	2.10-3.20	2.75±0.37
Caudal peduncle length (cm)	1.50-4.00	2.88± 0.75	2.20.2.90	2.71±0.18
Depth of caudal penduncle (cm)	1.00-3.40	2.16±0.68	1.30-2.60	2.05±0.29

** Superscript with different letters shows difference at 5% level of significance along the column

Table 2 shows the relationships between the mean values of the morphometric measurement of *Chrysichthys nigrodigitatus* from Kainji and Asejire dams, when presented as a percentage of standard length. The body weight form Kainji dam was 720.64g while that of Asejire dam was 405.71g, the caudal peduncle length from Kainji dam was 15.41cm to 17.46cm from Asejire dam, the length of pectoral fin and pelvic fin were also low from Kainji dam 18.50cm and 16.60cm to 23.49cm and 17.59cm respectively, the body depth from both locations were very close with Kainji dam (20.86cm) and (20.28cm) for Asejire dam, likewise pre anal length have similar values of 72.10cm from Kainji dam and 72. 29cm from Asejire dam but high value were recoreded in head length and pre dorsal fin length from Asejire dam with values of 30.14cm and 39.53cm to 27.97cm and 37.28cm from Kainji dam respectively.

The table also shows the mean values of the morphometric measurement of *Chrysichthys nigrodigitatus* from Kainji and Asejire dams, when presented as percentage of head length. The snout length from Kainji was high (36.87cm) while that of Asejire was low (32.72cm) but the length of dorsal fin base from Kainji dam was low (42.25cm) while that of Asejire dam was high (46.77cm). Eye diameter values were very close with 25.50cm from Kainji dam and 25.36cm from Asejire dam, pre anal fin length and pelvic fin length were high from Kainji dam (259.30cm and 59.60cm) while that of Asejire was low (58.42cm and 240.12cm), length of anal fin base was also high from the Kainji dam (42.01 cm) while that of Asejire was low (39.09cm) but pectoral fin length differs, where Kainji dam was low (66.59cm) and Asejire dam was high (77.97cm).

The table also divulges the mean values of the morphometric measurement of *Chrysichthys nigrodigitatus* from Kainji and Asejire dams, when presented as percentage of body depth against the caudal peduncle and depth of caudal peduncle where kainji dam were low (75.40cm and 54.82cm) while that of Asejire dam were high (86.28cm and 64.94cm) respectively. Likewise the morphometric measurement of *Chrysichthys nigrodigitatus* from Kainji and Asejire dams, when presented as percentage of caudal peduncle against depth of caudal peduncle was high in Asejire dam (75.18cm) while that of Kainji was low (74.13cm)

Table 2: Relationship between the Mean Values of the Morphometric Measurement of *Chrysichthys nigrodigitatus* from two Ecological Zones Presented in Percentages

	KAINJI	**ASEJIRE**
PARAMETERS	Mean ± Standard Error (%)	Mean ± Standard Error (%)
Mean values of the morphometric measurement of *Chrysichthys nigrodigitatus* presented as percentage of standard length		
Body weight	720.64 ± 337.24	405.71±1897
Caudal peduncle	15.41±1.53	17.46±1.63
Length of Pectoral fin	18.5±1.72	23.49±2.21
Length of Pelvic fin	16.6±1.70	17.59±1.59
Body depth	20.86±3.08	20.28±1.57
Head length	27.97±2.57	30.14±1.34
Pre dorsal fin length	37.28±2.28	39.53±1.70
Pre anal fin length	72.10±3.53	72.29±3.93
Mean values of the Morphometric measurement of *Chrysichthys nigrodigitatus* presented as Percentage of head length		
Snout length	36.87±3.11	32.72±3.40
Eye diameter	25.50±5.78	25.36±2.16
Length of the dorsal fin base	42.25±4.33	46.77±2.37
Pectoral fin length	66.59±7.68	77.97±6.94
Pelvic fin length	59.60±6.50	58.42±5.10
Pre anal fin length	259.30±20.88	240.12±13.71
Length of the anal fin base	42.01±8.30	39.09±4.17
Mean value of the Morphometric measurement of *Chrysichthys nigrodigitatus* presented as Percentage of body depth		
Caudal peduncle	75.40±12.90	86.28±7.94
Depth of caudal peduncle	54.82±5.18	64.94±7.61
Mean value of the Morphometric measurement of *Chrysichthys nigrodigitatus* presented as Percentage of caudal peduncle		
Depth of caudal peduncle	74.13±10.07	75.18±10.68

Table 3 shows the meristic count relationship and differences from the two water bodies against that of Paugy *et al.,* (2003) with the same numbers of dorsal fin rays, barbels and nostrils.

Table 3: Meristic Characteristic of *Chrysichthys nigrodigitatus* from the two Ecological Zones

PARAMETER	**KAINJI**	**ASEJIRE**	**AUTHOR Paugy *et al*. (2003)**
Dorsal fin rays	6	6	6
Dorsal spine	2	2	2
Anal fin rays	12	12-13	8-12
Anal spine	-	-	3-7
Pectoral fin rays	-	-	8-10
Pectoral spine	-	-	1
Pelvic fin rays	-	-	5
Maxillary barbels	2	2	-
Premaxillary barbels	4	4	-
Nostrils	4 (2 pairs)	4 (2pairs)	-

- The values were not determined

The following PCA were selected due to the fact that they show the similarities and differences from the two ecological zones.

Fig. 2 showed the PCA scatter diagram of the relationships and differences between the body depth and standard length of silver cat fish *Chrysichthys nigrodigitatus* from Kainji and Asejire dams. The whole samples of *Chrysichthys nigrodigitatus* from Asejire dam were imbedded in the samples collected from Kainji dam, this shown that there was no difference in the relationship between the body depth and the standard length, actually, the PCA scatter for Kainji samples were larger than the Asejire samples but was all due to the sizes of fish samples collected, fish samples from Kainji dam range from 15.00-36.40(cm) while that of Asejire dam just range from 19.00-25.20(cm). Likewise Fig 3 showed the PCA scatter diagram of the relationships and differences between the anal fin base length against the standard length of silver cat fish *Chrysichthys nigrodigitatus* from Kainji dam and Asejire dam. The whole samples of *Chrysichthys nigrodigitatus* from Asejire dam were almost imbedded in the samples collected from Kainji dam, but a spot which shown that there is little difference in their relationship. Similarly, Fig 4 showed the PCA scatter diagram of the relationships and differences between the head length against the standard length of silver cat fish *Chrysichthys nigrodigitatus* from Kainji dam and Asejire dam, the figure revealed that two points were not imbedded in the Kainji dam out of the Asejire samples collected. The whole samples of *Chrysichthys nigrodigitatus* from Asejire dam were almost imbedded in the samples collected from Kainji dam, this shown that there is difference in the relationship between head length against the standard length of silver catfish *Chrysichthys nigrodigitatus* from Kainji and Asejire dams.

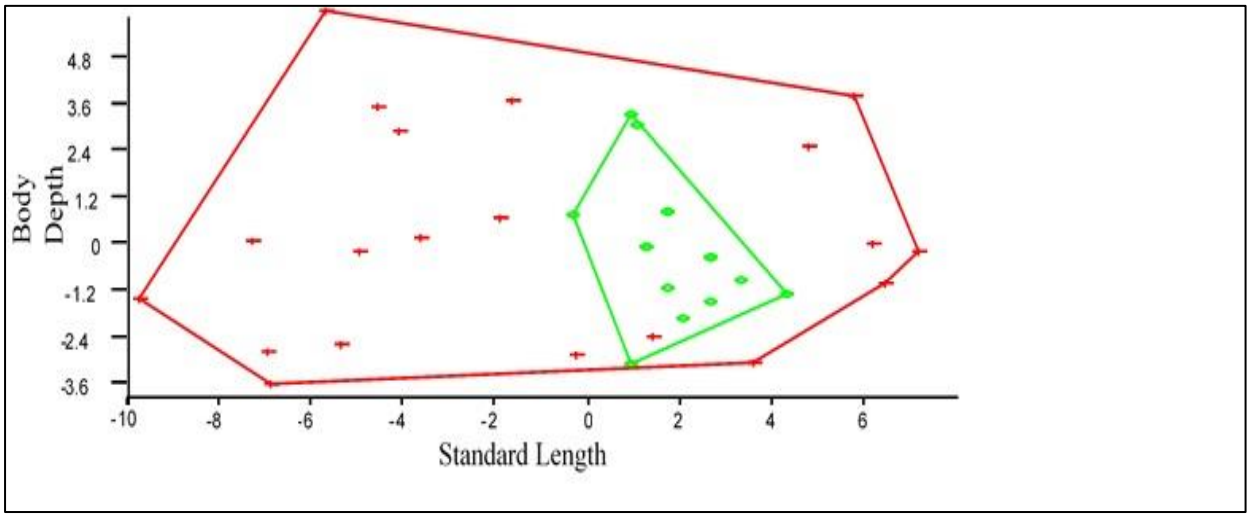


Figure: 2 PCA scatter diagram of the relationships and differences between the body depth and standard length of silver cat fish *Chrysichthys nigrodigitatus* from Kainji and Asejire dams

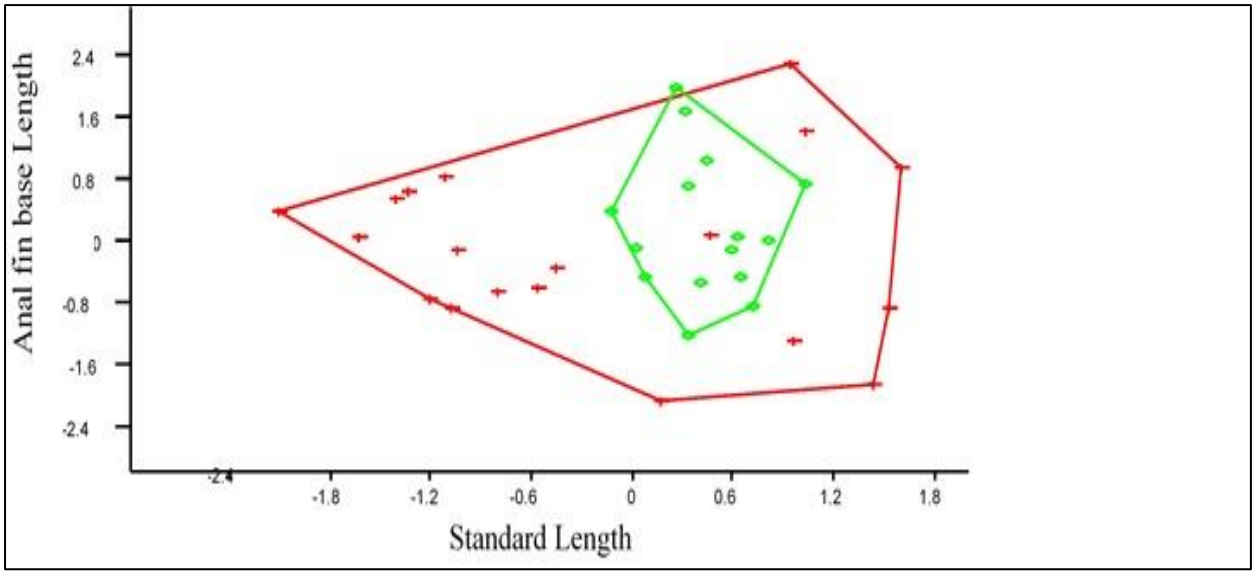
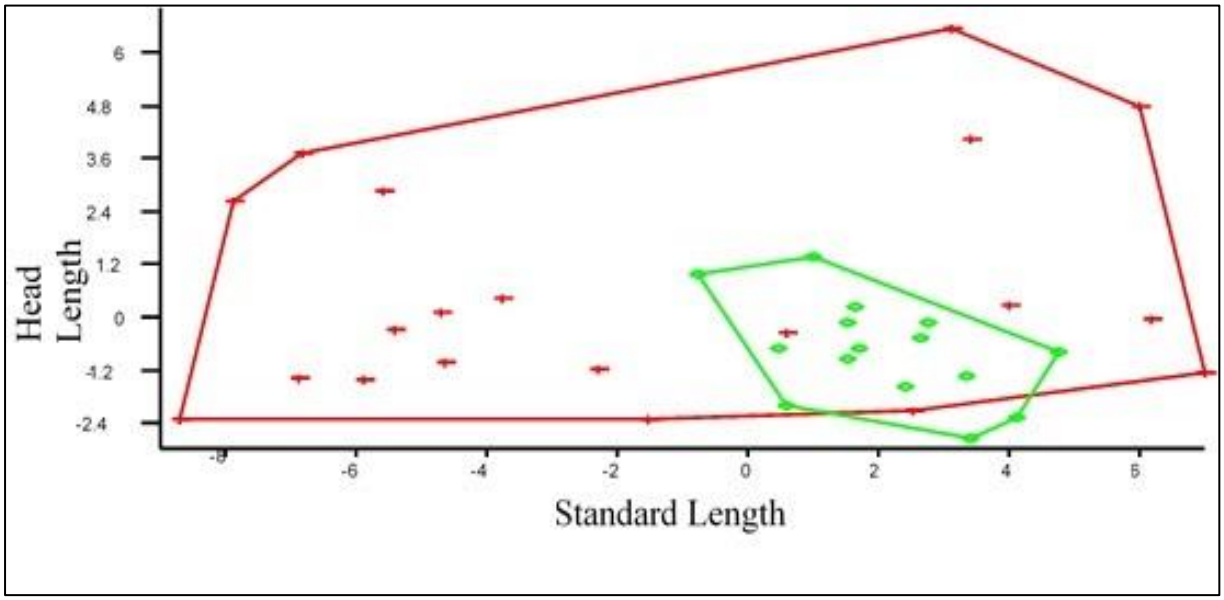


Fig 3 PCA scatter diagram of the relationships and differences between the anal fin base length against the standard length of silver cat fish *Chrysichthys nigrodigitatus* from Kainji dam and Asejire dam



KEYS: + = Kainji Lake**;** = Asejire Lake

Figure: 4 PCA scatter diagram of the relationships and differences between the head length against the standard length of silver cat fish *Chrysichthys nigrodigitatus* from Kainji dam and Asejire dam

Discussion

Morphometric measurement and meristic count of Chrysichthys nigrodigitatus

Morphometric measurement has been widely used to discriminate populations of various fish species (Elliot *et al.*, 1995; Uiblein, 1995; Hurlbut and Clay, 1998). The conventional approach for such analysis is based on measurements along the antero-posterior body axis and the depth measurements. Despite the advancement in the use of molecular techniques in the characterization of fish species, the importance of collecting necessary morphological data cannot be over emphasized.

Fish demonstrate greater morphological variation within and between populations than any other vertebrates in the world (Allendorfa *et al*., 1987; Winberger 1992), the observable differences in this two study area were not only restricted to bigger sizes of samples obtained from Kainji dam but also

differences in the morphometric measurement among some parameters. Table 1 values were influenced by the size of the fish samples and higher mean values in the parameters measured as observed from Kainji dam samples. Similarly, the significant differences ($P<0.05$) observed in the mean values of the samples from Kainji and Asejire dam were similar to a very large extend despite the differences in location. The parameters that showed significantly differences include the total length, body depth, body weight, standard length, snout length and the Pre anal fin length, all these have effect on the identification of the species, and it may be as a result of differences in the ecological zones. This position is further confirmed by the result of Table 2 which showed some differences in their morphological parameters when expressed as percentage of the standard length, head length, body depth and caudal peduncle respectively.

The environmental conditions such as food abundances and temperature has been implicated as main causes of the fish morphological plasticity (Allendorfa and Phelps, 1988; Swain *et al*., 1991 and Winberger 1992) and this study also conformed with their findings but contradicted that of Omoniyi *et al.* 2010 that close affinity between those population suggested that the two samples have similar hydrological conditions as constructed dams and similar antropogenic effects such as fishing pressure since both water bodies are being exposed as capture fisheries. More so, the differences observed could be environmentally cues such plasticity is thought to be an important adaptive strategy for population experiencing unstable environment (Stearns 1989, Scheiner, 1993).

As percentage of the standard length against the body weight, caudal peduncle length of the dorsal fin, length of the anal fin, length of pectoral fin, length of pelvic fin, body depth, head length, pre dorsal fin length and pre anal fin length were being identified as most important discriminating characters that would differentiate fish species as well as percentage of head length against snout length, eye diameter, length of the dorsal fin base, pectoral fin length, pelvic fin length, pre anal fin length and pre-anal fin length, also the mean values presented as percentage (%) of body depth against caudal peduncle and depth of caudal peduncle are used and the percentage (%) of caudal peduncle was used against depth of the caudal peduncle as shown in Table 2 that their mean values were different.

Similarly, PCA scatter diagram presented in Figs 2 to 4, especially Figs 3 and 4 shown that the two species were different from one another using mophometric measurement. Almost all the PCA scatter diagram of Asejire samples shows at least a point outside the Kainji samples which may be as a result of existed of another species from Asejire dam as reported by Taiwo and Aransiola (2003) that other species of *chrysicthy* such as *Chrysichthys walker* are found in Asejire dam.

In addition, the meristic characteristics shown in table 3 revealed that *Chrysichthys nigrodigitatus* have equal number of dorsal fins both the number of spines and fin rays with 2 and 6 respectively. Also the number of barbels were equal both maxillary barbels were 2 while pre maxillary barbles were 4 making total of 6 barbels, in addition the number of nostrils were 4 (2pairs) from both location all these founding conform with Paugy *et al.* 2003 but *Chrysichthys nigrodigitatus* in Asejire has either 12 or 13 anal fin rays which contradict that of Paugy *et al.* 2003 and that of Kainji dam that anal fin rays did not exceed 12, which may be due to the reason stipulated above according to Taiwo and Aransiola (2003) or modification due to differences in ecological zones, fishing activities and environmental factors.

Conclusion

Chrysichthys nigrodigitatus from Kainji dam and Asejire dam were not similar morphologically which means that morphological variations can be used as a mean of differentiating *Chrysichthys nigrodigitatus* from Kainji and Asejire dam, Likewise Meristic count also differ with the anal fin rays count. Therefore external features can be used to differentiate *Chrysichthys nigrodigitatus* from the two ecology zones.

Further studies should be carried out on *Chrysichthys nigrodigitatus* from other ecological zones to ascertain the effect of ecological zones on this fish species in Nigeria

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