BIOMENTRIC CHARACTERISTICS AND CONDITION FACTORS OF *Clarias gariepnus* AND *Hepsetus odoe* FROM THREE MAJOR RESERVOIRS OF EKITI-STATE, SOUTHWEST NIGERIA

ABSTRACT

The samples of 50 *Clarias gariepinus* from Ero, Egbe and Ado-Ekiti reservoirs and 66 *Hepsetus odoe* from Egbe and Ado-Ekiti reservoirs (not present in Ero- reservoir), Ekiti-State, Southwest, Nigeria were collected between July and October 22018 using cast net of 2.5- 3.5mm mesh size, bamboos and hooks. The samples were brought to Zoology and Environmental Biology Laboratory in Ekiti State University and measurements for morphometric (24) and meristic (11) characters of each of the investigated fish specimens were taking using standard procedures. To test the significance of morphological differences between *Clarias gariepinus and Hepsetus odoe* populations and the significance of morphological characters in relation to the body length, Analysis of variance (ANOVA) was used. Principal component analysis and Cluster analyses were further used to determine the level of similarity of the morphological characters using Paleontological statistics (PAST) software. The multivariate analysis was further used to evaluate the differences and similarities between the fish sample's populations from the three reservoirs. The analysis revealed the occurrence of heterogeneity between the two species in each reservoirs and homogeneity in both morphometric and meristic characters of each species populations, except the meristic characters of *Clarias gariepinus* from Ado-Ekiti reservoir that somehow differs from other two reservoirs. The result showed the potential for commercial purposes of the fish populations. However, genetic markers can be use in further studies to confirm the level of differences (phenotypic diversity) observed and assess the level of variation for meristic traits of *Clarias gariepinus* in these populations.

Key words: *Clarias gariepinus, Hepsetus odoe,* Morphometric, Meristic traits, Characteristics, Reservoir, Nigeria.

INTRODUCION

Dam is a structure or massive barriers built across stream, a river, or an estuary to confine and utilize the flow of water for human purposes. Reservoirs are man-made lakes which are formed by damming rivers to create an artificial impoundment for water storage, irrigation, hydropower electricity etc. This brings about lacustrine condition which can be conducive to the establishment and maintenance of fish stocks appropriate for exploitation through captured fisheries and aquaculture [1, 2]. *Clariidae* catfishes are air breathing fish naturally occurring in freshwater bodies in Africa, South-East Asia where they constitute significant component of catches. And was introduced all over the world in the year 1980s for aquaculture purpose and is found in countries for outside its natural habitat. *Clarias gariepinus* are readily recognized by their cylindrical body with scale less skin flattened bony head, small eyes elongated spineless dorsal fin and four pairs of barbells around the broad mouth. The anal, caudal and dorsal fins are not united. The *Clarias gariepinus* are of great importance as food and vital in the sustainable of the aquaculture with these attributes: ability to withstand handling stress especially low oxygen content, disease resistance, high growth rate, yield potential, fecundity and palability. And is one of the most readily acceptable species of *Clarias* in Nigeria because they grow to a large size [3]. The African Pike Characin is a predator. Fresh water *Characin* belonging to the family *Hepsetus*. It was considered that there was a single species of *Hepsetus. H. odoe* is the West African representative of the group. It is an elongated fish with a Pike-body. However, the species is a Characin and the Pike resemblance is due to convergent evolution. This species can reach up to about 26cm (11inches) in length. And this species is widely distributed around Western and Central Africa. It inhabits slow running and shallow waters of rivers in the plains as well as estuaries and a variety of other freshwater habits. *H. odoe* is piscivorous, feeding on several species of smaller fish by laying ambush in dense vegetation, and they feed primarily on *Cichilds* and *Mormyrids*. The African Pike (*H. odoe*) is a highly priced freshwater food fish species in Nigeria especially because of its availability all year round, affordability, and tasteful flesh, economic and nutritional value [4]. Morphometric and meristic studies of animals are part of the vigorous tools for measuring discreteness of the same species [5, 15]. Morphometric studies of animals are not only essential to understand the taxonomy but also the health of species involved in the environment. These traits reveal the inter relations between various body parameters like length, weight, fecundity etc. Meristic traits are countable structures occurring in series (such as vertebral column, fin rays, number of gill filament, number of gill arch and racker, etc) in fish. These characters are among those most commonly used for differentiation of species population [2]. Since morphometric characterization of fish is not only essential to the understanding of the classification of fish but also, the health of the species involved; the shape and structures are unique to the species and the variations in its features are related to the habit and habitat among the fish species. This study was therefore designed to assess the population of *C. gariepinus* and *H. odoe* collected from Ero, Egbe and Ado-Ekiti- reservoirs through their morphometric characteristics and meristic traits.

MATERIALS AND METHODS

STUDY SITES

Clarias gariepinus and *Hepsetus odoe* samples were collected from Ado- Ekiti reservoir in Ado- Ekiti, Egbe- reservoir in Egbe- Ekiti and Ero- reservoir in Ikun- Ekiti, Ekiti, Nigeria.

2.0 MATERIALS AND METHODS

2.1 STUDY SITES

Clarias gariepinus and *Hepsetus odoe* samples were collected from Ado- Ekiti reservoir in Ado- Ekiti, Egbe- reservoir in Egbe- Ekiti and Ero- reservoir in Ikun- Ekiti, Ekiti, Nigeria.

2.1.1 Ado- Ekiti Reservoir (Ureje reservoir)

It is situated on an undulating plane of an average height of about 440m above sea – level and surrounded by highlands. The reservoir lies between latitude 7^0 37’ north and longitude 5^0 13’ East of the Equator.

The Ureje reservoir, Ado- Ekiti was constructed by putting a dam across Ureje River in Ado – Ekiti in 1958 for the supply of water for domestic uses and production of fish for Ado- Ekiti community and its environment. The full capacity of the reservoir was about 47 million gallons of water.

2.1.2 Egbe Water Reservoir

The reservoir is located in an undulating plane surrounded by highlands of which run – offs also feed the reservoir during raining periods. Egbe water reservoir was constructed by putting a dam across Osse River. The River takes its source from Kwara State, Nigeria and flows from the north to south of Ekiti through Ode- Ekiti to Egbe – Ekiti. The location of the reservoir is on latitude 7^{0} $36^{!}$ And longitude 5^{0} $36^{!}$ East of the Equator; it was built in 1957 by damming this Osse River at Egbe – Ekiti. The reservoir was commissioned in 1989. And it covers an area of 26.5 hectares with the depth of about 64m. The capacity of the reservoir is about 144 million cubic meters.

2.1.3 Ero –Reservoir

Ero reservoir is a tropical reservoir situated at Ikun – Ekiti. It is an earth filled embankment with a length of 662m and an impoundment area of 4.5km. It was commissioned in 1985. The water level is about 504 containing about 2009million cubic meters. It lies between latitudes 7^{0} $15^{!}$ – 8^{0} $5^{!}$ And 4^{0} $45^{!}$ – 5^{0} $45^{!}$

2.2 Collections of Fish Samples

Fish samples used in this study were collected from landing sites through artisanal fishermen at the bank of the water reservoirs on every Monday at Ero- reservoir, Wednesday at Egbe- reservoir and Friday at Ado- reservoir within a week for a period of twelve weeks July to October, 2018. The fish were collected with the aid of cast netting of 2.5 – 3.5 mm mesh size, bamboos and hooks. The fish samples collected were counted and sorted in to different species on the field and were transported to the Post Graduate Laboratory of Zoology and Environmental Biology Department, Ekiti State University, Ado – Ekiti for further practicals.

2.3 Identification of Fish Samples

C. gariepinus and *H. odoe* was identified by following the method of [6] and [7].

2.4 DATA COLLECTION

Twenty four (24) morphometric characters and Eleven (11) meristic traits were taken on each fish specimen. The parts were measured following standard anatomical reference [8]. The specimens weights (measurement of the fish mass) were first measured using the electronic Citizen weighing balance (MP-3000 with max-3000g and min-5g).

Standard Length (SL), Total Length (TL), Dorsal Fin Length (DFL) , Anal Fin Length (AFL), Pectoral Fin Length (PFL), Spine Length (SPL), Head Length (HL), Snout Length (SNL) Length of occipital fontanelle (OFL), Pre-Anal Distance (PAD), Pre-Ventral Distance (PVD), Pre- Pectoral Distance (PPD), Pre- dorsal distance (PDD), Distance between Dorsal and Caudal fin (DDCF), Distance between Occipital process and Dorsal fin (DODF), Caudal peduncle Depth (CPD), Body Depth (BD) (Width), Head Width (HW), Inter -orbital Distance (ID), Eye Diameter (ED), Occipital fontanelle Width (OFW), Distance between snout and Occipital process (DSO) and Mouth Length (NL)

Eleven (11) meristic traits counted include: number of barbells (nB), numbers of Gills (nG), number of Spines (nS), number of Gill Arch (nGA), Number of Gill Filaments(nGF), number of Gill rakers (nGR), Dorsal fin rays (DFR), Anal Fin rays (AFR), Pectoral Fin Rays(PFR), Pelvic Fin rays (PvFR), Number of vertebrae Colum (nVC) were counted.

2.5 Condition Factor

The condition factor (K) which is defined as the wellbeing of the fish was calculated. K is a useful index for monitoring of feeding intensity, age and growth rates. The K value was determined by using

$$K = \frac{W}{L^3} \times 100$$

Where, W = weight of fish in grammes and L = length of fish in centimetres

2.6 Data Analysis

One way analysis of variance (ANOVA) was carried out on morphometric measurements to test the degree of variation among the fish species from the three location at P= 0.05 probability.

Morphometric measurements were standardized to fish size (SL) in accordance with [5, 8] to alleviate errors due to allometric growth using percentage standard length as it follows Mn = (Mo/SL) %, where, Mn is the corrected size, Mo is the original measurement (total length); and SL is the standard length. The measurements of each of the meristic traits were not standardized because the meristic characters are fixed early in development and less susceptible to environmental variables.

The data obtained from the morphometric characteristics and meristic traits were then analyzed with Principal Component Analysis (PCA) and Cluster Analysis (CA). PCA and CA on morphometric and meristic data were evaluated using Paleontological Statistics (PAST) software. Population centroids with 95% ellipses obtained from the PCA scatter diagram were used to observe the relationships among populations [5]. PCA loading method was used to show the traits with the highest variation within the population and CA was used to show the relationship in their Clustering patterns [9] using the unweight Pair Group Method with arithmetic mean for phenogram or dendrogram grouping.

3.0 RESULTS

In this study, a total number of One hundred and sixteen (116) fish species was collected. The numbers of collections were made up of fifty (50) *Clarias gariepinus* (43.1%) across the three reservoirs and *Hepsestus odoe* (56.9%) from Egbe and Ado-Ekiti reservoirs because *H. odoe* were not found in Ero- reservoir (i.e *H. odoe* is not available at Ero reservoir).

3.1 Morphometric Characteristics and Meristic Traits

Table 1: Mean values of the morphometric and meristic traits of *Clarias gariepinus* from Ero, Egbe and Ado-Ekiti- reservoirs, Ekiti- State, Nigeria

Characteristics	ERO MEAN±SD	EGBE MEAN±SD	Ado-Ekiti MEAN±SD
SL	32.31±4.23^{b}	29.80±9.29^{a}	36.56±3.61^{c}
TL	35.76±7.64^{a}	34.67±9.55^{a}	42.47±4.02^{b}
W	319.13±152.18^{a}	379.60±268.40^{b}	542.11±159.38^{c}
DFL	20.93±3.56^{a}	20.18±4.46^{a}	24.06±2.57^{b}
AFL	14.31±2.17^{a}	14.91±3.31^{a}	16.86±3.32^{b}
PFL	3.91±0.72^{b}	3.07±0.65^{a}	3.36±0.53^{a}
HL	8.88±1.05^{a}	8.51±3.38^{a}	11.12±1.28^{b}
SNL	2.39±0.38^{a}	2.34±0.37^{a}	2.86±0.24^{a}

OFL	2.86±0.69^{a}	2.14±0.35^{a}	2.06±0.34^{a}
PAD	17.81±2.59^{a}	16.64±5.92^{a}	21.42±1.62^{b}
PvD	15.59±1.70^{b}	13.79±4.79^{a}	17.78±1.76^{c}
PPD	6.99±0.69^{a}	6.35±2.11^{a}	8.57±1.12^{b}
PDD	11.21±1.56^{b}	9.58±2.89^{a}	11.61±1.17^{b}
DDCF	1.03±0.24^{a}	1.51±0.94^{a}	1.63±0.32^{a}
DODF	1.94±0.28^{a}	1.76±0.33^{a}	1.78±0.34^{a}
CPD	2.24±0.36^{a}	1.80±0.66^{a}	2.79±1.12^{b}
BD	4.24±0.66^{a}	5.06±1.67^{b}	5.58±1.05^{b}
HW	2.19±0.29^{a}	2.58±0.92^{a}	3.33±0.66^{b}
ID	3.60±0.47^{a}	3.00±1.10^{a}	3.76±0.67^{a}
ED	0.53±0.07^{a}	0.48±0.12^{a}	0.55±0.06^{a}
OFW	2.93±0.70^{b}	2.64±0.98^{b}	3.53±0.28^{a}
DSO	6.73±0.68^{a}	7.60±13.47^{b}	5.90±2.17^{a}
NL	3.00±0.70^{a}	2.89±0.74^{a}	3.72±0.26^{b}
nB	8.00±0.00^{a}	11.33±16.33^{b}	8.00±0.00^{a}
nG	4.00±0.00^{a}	4.00±0.00^{a}	4.00±0.00^{a}
nGA	8.00±0.00^{a}	11.33±16.33^{b}	8.00±0.00^{a}
nGF	1152.00±162.38^{a}	1351.00±95.26^{b}	1683.11±33.68^{c}
AFR	48.75±2.82^{a}	52.54±4.53^{b}	48.28±2.42^{a}
PFR	9.63±0.92^{b}	8.88±0.85^{a}	8.56±1.25^{a}
PvFR	5.75±0.46^{a}	6.00±0.00^{a}	5.89±0.32^{a}
DFR	67.50±4.38^{b}	63.33±5.50^{a}	63.94±3.24^{a}
nVC	55.75±3.06^{a}	56.42±1.72^{b}	56.44±1.85^{b}

Mean values in the same column with the same superscripts are not significantly different from each other (P= 0.05)

Table 2: Mean values of the morphometric and meristic traits of *Hepsetus odoe* from Egbe and Ado-Ekiti- reservoirs, Ekiti- State, Nigeria

Characteristics	Egbe- reservoir MEAN±SD	Ado-Ekiti- reservoir MEAN±SD
SL	23.37±2.93^{a}	23.74±3.61^{a}
TL	28.56±3.13^{a}	28.81±6.09^{a}
W	193.79±83.80^{a}	192.87±80.62^{a}
DFL	2.71±0.47^{a}	2.68±0.44^{a}
AFL	2.46±0.40^{a}	2.24±0.32^{a}

PFL	3.67±0.66 [a]	3.93±0.72 [a]
HL	7.05±0.65 [a]	7.54±1.08 [a]
SNL	3.29±0.54 [a]	2.93±0.67 [a]
OFL	3.14±0.70 [a]	3.57±0.73 [a]
PAD	19.20±2.39 [a]	19.46±3.18 [a]
PvD	13.85±1.96 [a]	13.44±2.35 [a]
PPD	6.69±0.85 [a]	6.80±0.90 [a]
PDD	14.80±2.02 [a]	14.83±1.85 [a]
DDCF	5.14±0.94 [a]	5.51±0.81 [a]
DODF	5.57±0.96 [a]	5.99±0.87 [a]
CPD	2.44±0.44 [a]	2.40±0.35 [a]
BD	4.67±0.79 [a]	4.83±0.63 [a]
HW	3.06±0.51 [a]	2.97±0.81 [a]
ID	2.20±0.28 [a]	2.17±0.26 [a]
ED	0.97±0.11 [a]	0.97±0.10 [a]
OFW	2.11±0.27 [a]	2.33±0.36 [a]
DSO	3.61±0.66 [a]	3.62±0.56 [a]
NL	1.83±0.33 [a]	1.82±0.33 [a]
nG	4.00±0.00 [a]	4.00±0.00 [a]
nGA	8.00±0.00 [a]	8.00±0.00 [a]
nGF	1090.97±57.53 [a]	1057.80±87.44 [a]
nGR	189.89±12.45 [a]	192.33±9.68 [a]
AFR	11.11±0.93 [a]	12.13±0.57 [a]
PFR	12.11±0.93 [a]	12.13±0.57 [a]
PvFR	8.94±0.24 [a]	8.70±0.47 [a]
DFR	8.94±0.24 [a]	8.70±0.47 [a]
nVC	39.17±5.10 [a]	41.77±2.91 [a]

Mean values in the same column with the same superscripts are not significantly different from each other (P= 0.05)

The mean values for morphometric characters and meristic traits of *Clarias gariepinus* from Ero, Egbe and Ado-Ekiti reservoirs are listed in Table 1. The result shows that the mean body weight of *Clarias gariepinus* from three the populations ranged from 319.13 ± 152.18 in Ero-reservoir to 542.11 ± 159.38 in Ado-Ekiti reservoir respectively. The mean weight of *C. gariepinus* samples were significantly different (P= 0.05) across the three populations. The mean total lengths ranged from 34.67 ± 9.55cm in Egbe population to 42.47 ± 4.02cm from Ado-Ekiti reservoir respectively. The mean total length of *Clarias gariepinus* sample from Ero-reservoir was not statistically different from Egbe fish population, but significantly different Ado-Ekiti population (P= 0.05).

The mean values on other morphometric characters of *C. gariepinus* were significantly different across the three populations except in SNL, OFL, DDCF, DODF, ID and ED which were similar in the three population samples (p> 0.05).

The mean value for meristic characters of *C. gariepinus* showed the number of gill filament of *C. gariepinus* from the three populations ranged from 1152.00 ±162.38 in Ero- reservoir to 1683.11±33.68 in Ado-Ekiti reservoir respectively. The mean number of gill filaments of *C. gariepinus* were significantly difference across the three populations (p= 0.05). The mean values on other meristic characters of *C. gariepinus* were significantly different across the three populations except in nG, AFR and PvFR.

The mean morphometric characters and meristic traits of *Hepsetus odoe* from Egbe and Ado-Ekiti reservoirs, Ekiti- State, Nigeria are listed in Table 2. The result shows that the mean body weights of *Hepsetus odoe* from the two populations are 192.87± 80.62 from Ado-Ekiti reservoir to 193.79 ± 83.80 from Egbe-reservoir respectively. The means were not statistically different from each other at 95% level of significant. All other morphometric characters of *H. odoe* from Egbe population were not significant difference from Ado-Ekiti population (p> 0.05). Table 2 also shows that all meristic characters values of *Hepsetus odoe* such as number of gill (nG), number of gill filaments (nGF), number of gill arches (nGA), number of gill rakers (nGR), anal fin rays (AFR), pectoral fin rays (PFR), pelvic fin rays (PvFR), dorsal fin rays (DFR) and number of vertebral column (nVC) were not varied among the two populations (P= 0.05).

3.2 Meristic Frequency

Table 3: Meristic traits frequency for *Clarias gariepinus* and *Hepsetus odoe* across the three main reservoirs (Ero, Egbe and reservoirs)

Name of species	Name of reservoir	nB	nG	nS	nGA	nGF	nGR	AFR	PFR	PvFR	DFR	nVC
C.	Ero	8	4	-	8	976-	180	45-	7-	6	25-	50-

gariepinus						1400	-280	53	10		27	60
	Egbe	8	4	-	8	1040-1400	510-650	52-60	9-10	6	27-28	55-60
	Ado-Ekiti	8	4	-	8	1650-1750	325-380	47-50	9-10	6	27-28	53-70
H. odoe	Egbe	-	4	-	8	1000-1380	184-220	10-12	10-12	9	9	30-38
	Ado-Ekiti	-	4	-	8	880-1100	184-220	10-11	10-13	9-10	9-10	40-45

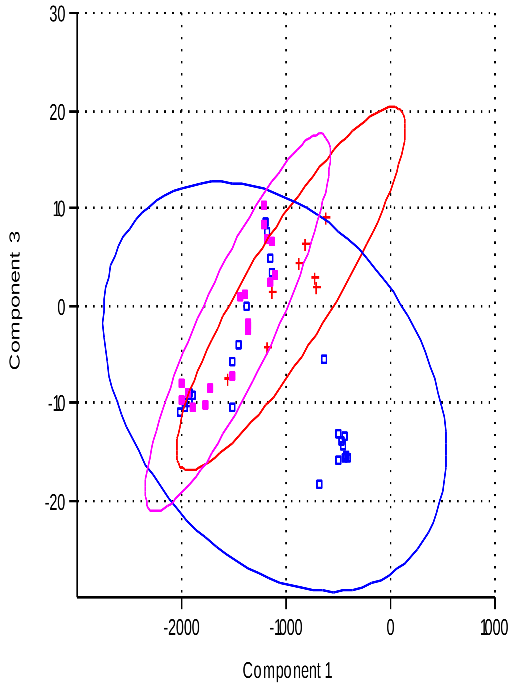
nB= number of barbells, nG= number of gills, nS= number of spine, nGA= number of gill arches, nGF= number of gill filaments, nGR= number of gill rackers, AFR= anal fin rays, PFR= pectoral fin rays, PvFR= pelvic fin rays, DFR=dorsal fin rays, nVC= number of vertebral column.

Clarias gariepinus

Clarias gariepinus are usually with dark black colouration on the back, fading to a white belly. It has no scale, 8 barbells, 4 gills, no dorsal spine, 4 pairs of gill arch (upper and lower), 976-1500 gill filaments, 180-380 gill rakers, 45-60 anal fin rays, 7-10 pectoral fin rays, 6 pelvic fin rays, 55-70 dorsal fin rays (soft) and 50-70 vertebral columns depending on the geographical location (Table 3).

Hepsetus odoe

Hepsetus odoe is ovoid or oviform, short and wide body surface, silvery colouration with black stripes or bands, has scales all over its body, no barbell, 4 gills, 14-17 dorsal spines, 13-15 dorsal soft rays, 27-29 dorsal fin rays, 4 pairs of gill arch (upper and lower), 1040-1240 gill filaments, 180-280 gill rakers, 10-14 anal fin rays, 11-12 pectoral fin rays, 6 pelvic fin rays and 25-38 vertebral columns depending on the habitat (Table 3).



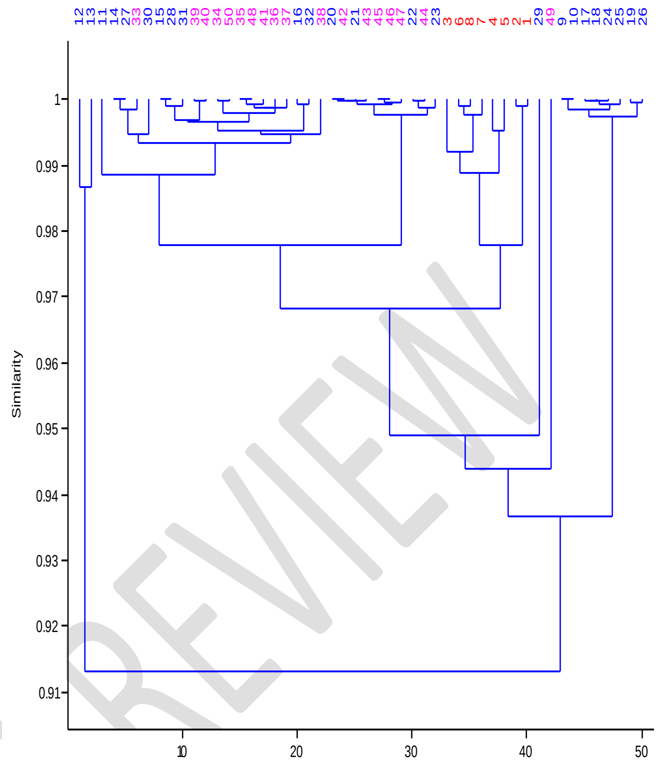
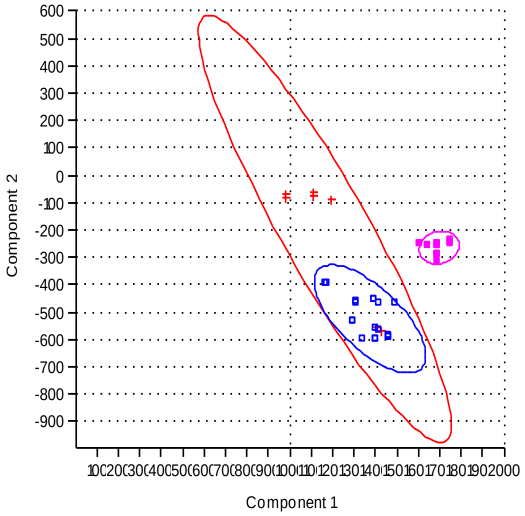


Fig.1: PCA scatter diagram for morphometric of *C. gariepinus* from all the reservoirs using 95% ellipses Ero (red), Egbe (blue) and Ado-Ekiti (pink)

Fig. 2: cluster analysis for morphpmetric of *C. gariepinus* from Ero, Egbe and Ado-Ekiti- Ekiti reservoirs using Rho similarity measure



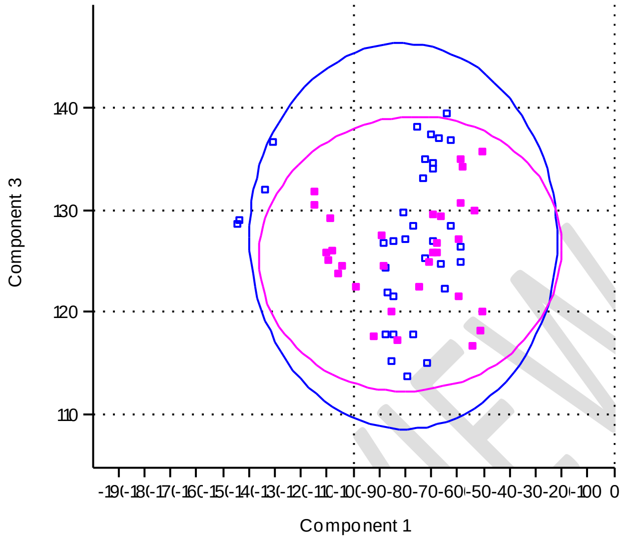


Fig. 3: PCA scatter diagram for meristic of *C. gariepinus* from all the reservoirs using 95% ellipses Ero (red), Egbe (blue), Ado-Ekiti (pink).

Fig. 4: PCA scatter diagram for morphometric of *Hepsetus odoe* for two reservoirs Egbe (blue), Ado-Ekiti (pink)

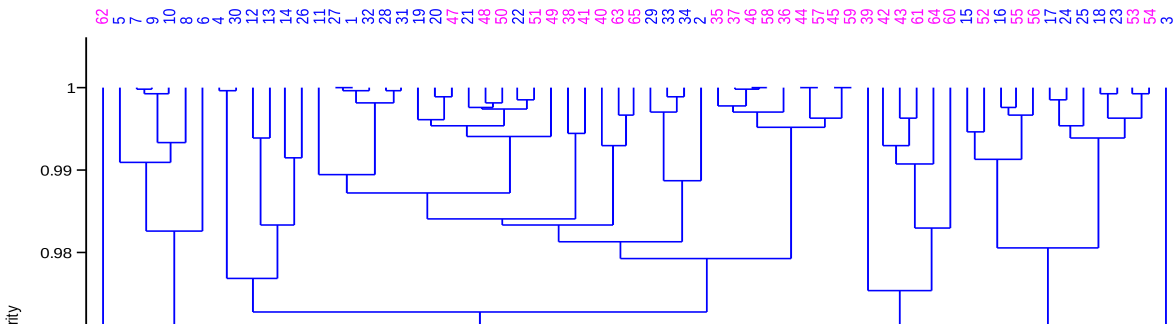


Fig. 5: Cluster analysis for morphometric of ***H. odoe*** from Ero and Egbe- reservoirs using Rho Similarity measure

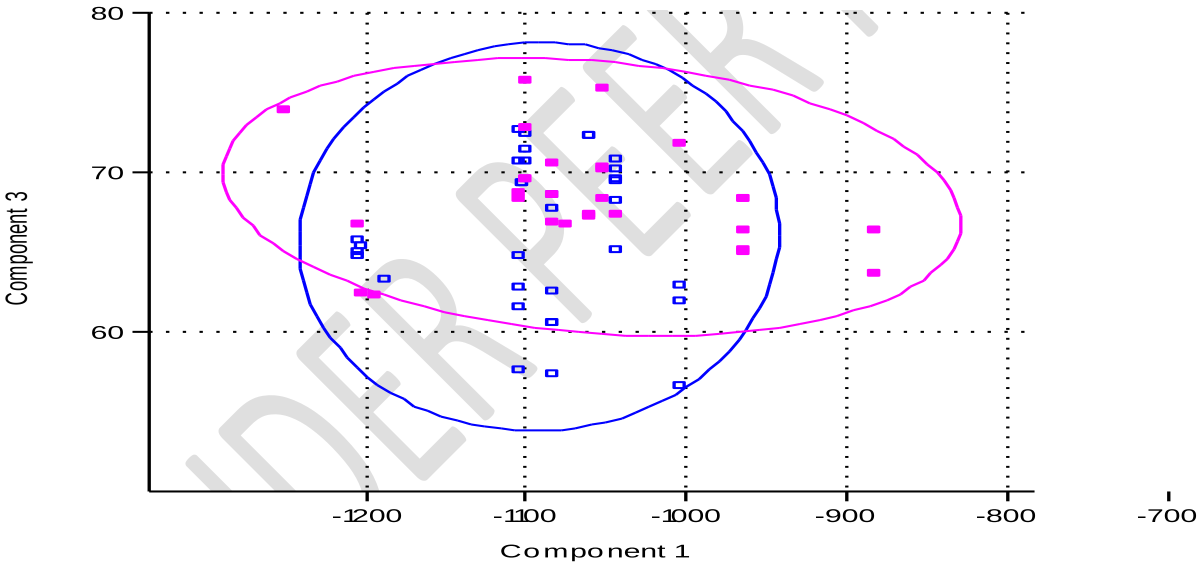


Fig. 6: PCA scatter diagram for meristic characters of *H. odoe* from the two reservoirs, Egbe (blue) and Ado-Ekiti (pink).

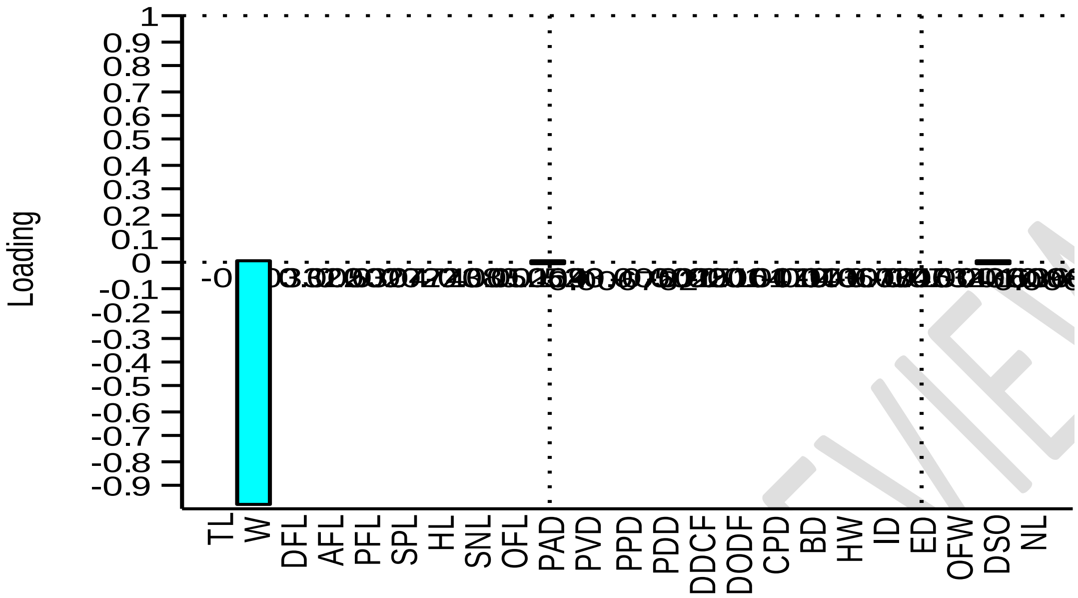


Fig. 7: PCA loadings for morphometric of *C. gariepinus* in Ero, Egbe and Ado-Ekiti- reservoirs

Table 4a: PCA loadings for morphometric of *C. gariepinus* from Ero, Egbe and Ado-Ekiti- reservoirs

Traits (cm)	Loadings
TL	-0.003322
W	-0.9999
DFL	0.005304
AFL	0.002774
PFL	0.002238
SPL	0
HL	-0.005269
SNL	0.001523
OFL	0.004
PAD	-0.006762
PVD	-0.005012
PPD	-0.002511
PDD	-0.0006479
DDCF	-0.001007
DODF	0.001143
CPD	-0.001677
BD	-0.001345
HW	-0.001734
ID	-0.001236
ED	0.0001636
OFW	-0.0009802
DSO	-0.006863
NL	0.0004559

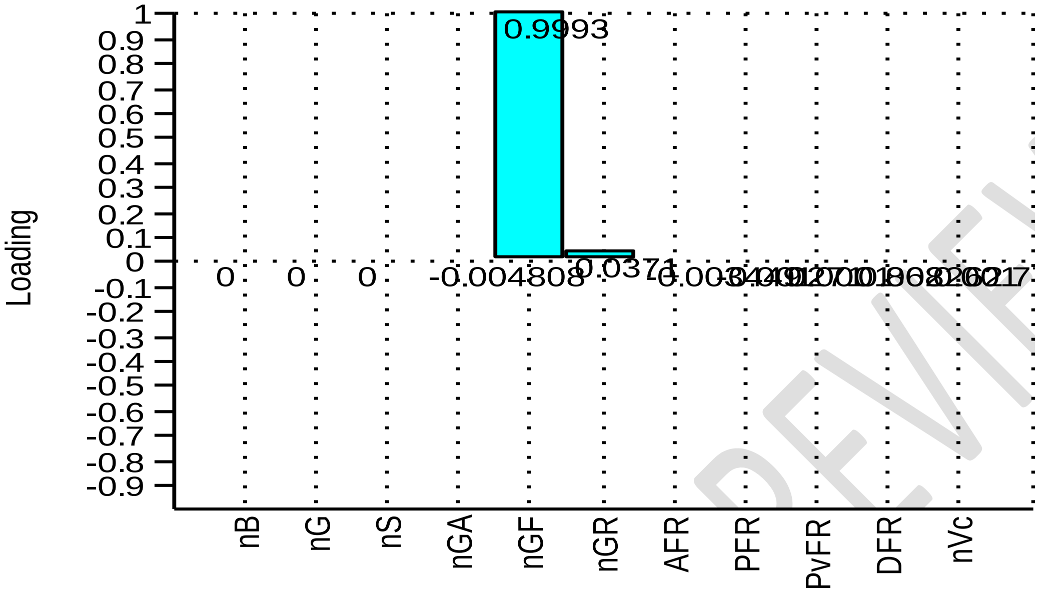


Fig. 8: PCA Loadings for meristic characters of *C. gariepinus* from all the reservoirs

Table 4b: PCA Loadings for meristic characters of *C. gariepinus* from Ero, Egbe and Ado-Ekiti-reservoirs

Traits (cm)	Loadings
nB	0
nG	0
nS	0
nGA	-0.004808
nGF	0.9993
nGR	0.0371
AFR	-0.003449
PFR	-0.001271
PvFR	0.0001868

DFR	0.002262
nVC	0.001773

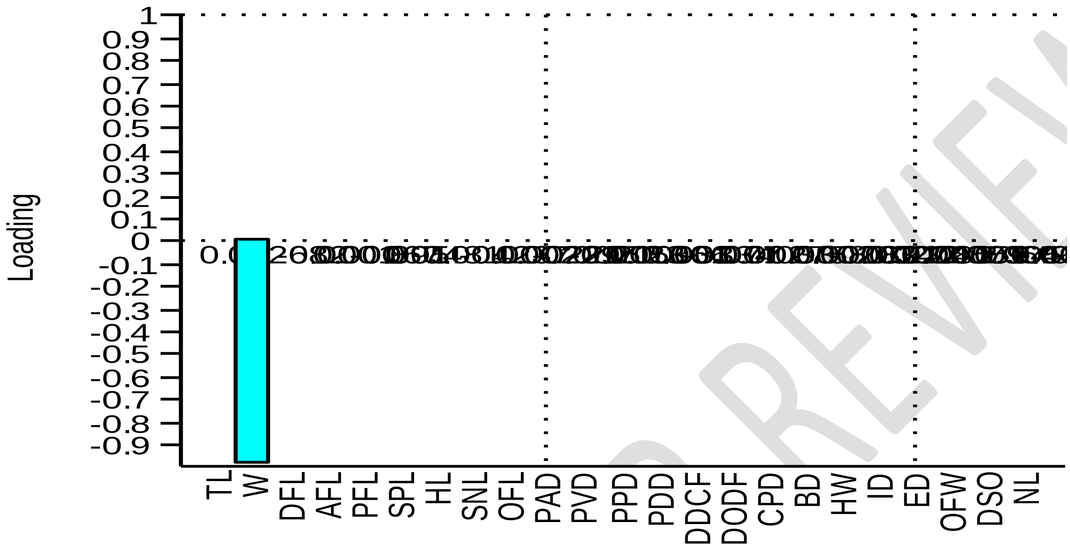


Fig. 9: PCA loadings for the morphometric of *H. odoe* from two reservoirs

Table 5a: PCA loading for morphometric characters of *H. odoe* from two reservoirs

Traits (cm)	Loadings
TL	0.002682
W	-0.9999
DFL	-0.0001895
AFL	0.00067
PFL	-0.001481
SPL	0
HL	0.004237
SNL	-0.0002295
OFL	0.002217
PAD	-0.002123
PVD	-0.005366
PPD	0.0003334
PDD	0.001077
DDCF	-0.001033
DODF	0.002758
CPD	-0.0002034
BD	0.0008222
HW	-0.002745
ID	0.0008179
ED	0.0005649
OFW	0.00164
DSO	0.005738

NL	0.00154

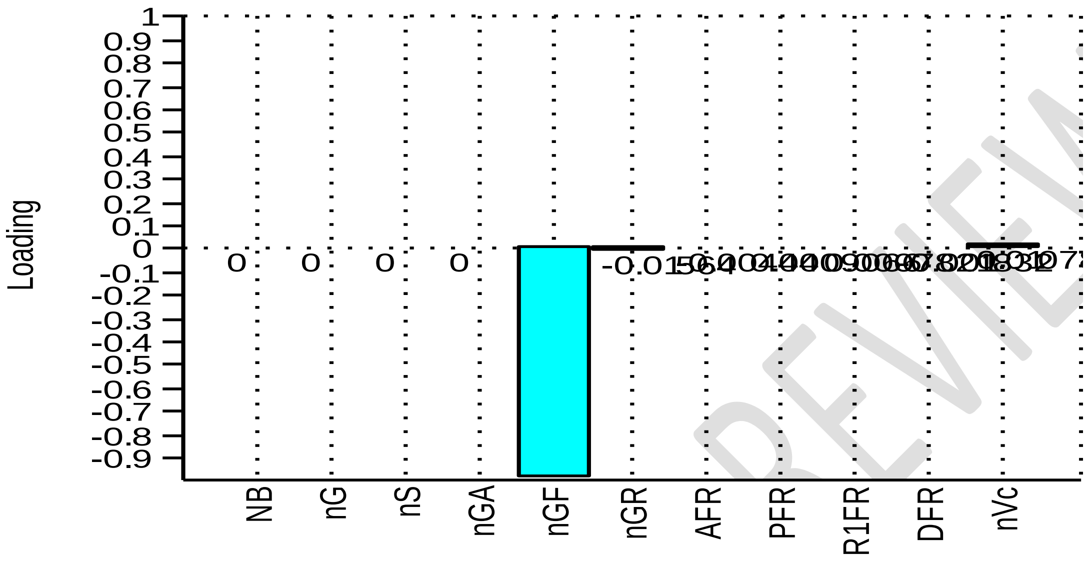


Fig. 10: PCA Loadings for meristic characters of *H. odoe* from two reservoirs

Table 5b: PCA Loadings for meristic characters of *H. odoe* from two reservoirs

Traits (cm)	Loadings
nB	0
nG	0
nS	0
nGA	0
nGF	-0.9998
nGR	-0.01564
AFR	-0.00444
PFR	0.0009066
PvFR	0.0007821
DFR	-0.001832

nVC	0.01078

3.3 Analysis of *C. gariepinus* across the three reservoirs (Ero, Egbe and Ado-Ekiti)

The Principal Component Analysis for morphometric and meristic characters of *Clarias gariepinus*, the PCA scatter diagram using 95% ellipses for the morphometric characters of *C. gariepinus* species obtained from the three populations of study showed that there is an overlap of data between populations from Ero-Reservoir (red) and Ado-Ekiti -Reservoir (pink), and a big overlap between Egbe-Reservoir (blue) and the other reservoirs, which revealed a great homogeneity of *C. gariepinus* from the populations (Fig. 1). The cluster Analysis (dendrogram) *C. gariepinus* from all the reservoirs using Rho similarity measure showed Ero-Reservoir (red) especially Egbe-Reservoir (blue) and Ado-Ekiti Reservoir (pink) were mixed and has a single homogeneity of the C. *gariepinus* from the three populations (reservoirs) Fig. 2. The principal component Analysis (PCA) Scatter diagram using 95% of ellipses for meristic traits or characters of *C. gariepinus* form the three populations of study showed that, the circle representing the data in the population of Egbe-Reservoir (blue) are inside circle representing the data in the population of Ero-Reservoir (red) and it also overlapped and there is a clear separation between population of Ado-Ekiti Reservoir (pink) and the other two reservoirs, which indicate that the *C. gariepinus* from Egbe-reservoir and Ero-reservoir have meristic characters (traits) in common and are homogeneity. And also that *C. gariepinus* from Ado-Ekiti -Reservoir were significantly different i.e varies from the two reservoirs in meristic characters Fig. 3. The PCA loading for morphometric characters for *C. gariepinus* showed that there were no significant differences of variations (homogeneity) among the characters of *C. gariepinus* from the studied populations shows ‘number of gill filament’ (loading 0.9993) as the meristic character that varied most among the three *C. gariepinus* populations Fig.8 and table 4b.

Table 6a: distribution of variation of morphometric data for ***C. gariepinus*** among the principal components

PC	EIGEN VALUES	% VARIANCE
1	264431	99.701
2	644.606	0.24304
3	66.0935	0.02492
4	36.5261	0.013772
5	16.8341	0.0063471
6	7.69913	0.0029029
7	6.25831	0.0023596

8	3.81471	0.0014383
9	2.29167	0.00086405
10	2.19764	0.0008286
11	1.57804	0.00059499
12	1.26942	0.00047862
13	0.900055	0.00033936
14	0.867731	0.00032717
15	0.496435	0.00018718
16	0.297644	0.00011222
17	0.170835	6.4412E-5
18	0.117212	4.4194E-5
19	0.062789	2.3674E-5
20	0.0480277	1.8108E-5
21	0.0298724	1.1263E-5
22	0.0127403	4.8036E-6
23	1.6424E-17	6.1925E-21

Table 6b: distribution of variation of meristic data for *C. gariepinus* among the principal components

PC	EIGEN VALUE	% VARIANCE
1	47576.4	60.633
2	30722.5	39.154
3	126.852	0.16166
4	23.0733	0.029405
5	13.3345	0.016994
6	3.14119	0.0040032
7	0.803213	0.0010236
8	0.0560874	7.148E-5
9	0	0
10	0	0

11	0	0

The Eigen values and corresponding percentage variance from principal component analysis PCA of the morphometric and meristic characters of *C. gariepinus* respectively across the three studied populations as shown in tables 6a and 6b respectively. These components are showing the distribution of variation among the components in the CA for morphometric characters, PCI accounted for 99.7%of the variation, PC XVII for 6.4% and PC XXIII for 6.1% (Table 6a), for meristic characters, PCI 60.6% of the variation, PC II for 39.1% and PC VIII for 7.1% (Table 6b).

3.4 Analysis of *H. odoe* across the two reservoirs (Egbe and Ado-Ekiti-reservoir)

The principal component analysis of morphometric and meristic characters of *Hepsetus odoe* was found in two reservoirs (locations). The PCA scatter diagram using 95% ellipses for the morphometric characters of *H. odoe* species obtained from the two populations showed that there is an overlap of data between populations from Egbe-Reservoir (blue) and Ado-Ekiti Reservoir (pink), which revealed a great homogeneity of *H. odoe* from the populations Fig.4. The cluster Analysis (Dendrogram) of *H. odoe* from two reservoirs using Rho similarity measure showed Egbe-Reservoir (blue) and Ado-Ekiti Reservoir (pink), the two colour were mixed and can be trace to a single Origin (Ancestors) which also confirm the great homogeneity of the *H. odoe* from the two populations Fig 5. The principal component analysis (PCA) scatter diagram using 95% of ellipses for meristic characters of *H. odoe* from the two populations showed that, there is an overlap of data between populations from Egbe-Reservoir (blue) and Ado-Ekiti Reservoir (pink). It revealed a great homogeneity in meristic characters of *H. odoe* from the two populations Fig. 6.

The PCA loadings for morphometric characters for *H. odoe* showed that there were no significant differences (variations), indicating the level of similarity among the characters of *H. odoe* from the studied populations Fig. 9 and Table 5a. The PCA loadings for meristic characters of *H. odoe* from the two populations showed a little variation in the “number of Vertebrate Column” (Loadings 0.01078) as the meristic character that varied most the among meristic characters of two populations of *H. odoe* Fig 10 and Table 5b.

The Eigen values and corresponding percentage variance from principal component analysis PCA of the morphometric and meristic characters for *H. odoe* respectively across the two populations as shown in tables 7a and 7b respectively. These components are showing the distribution of variation among the components in the PCA. For morphometric characters, PC I accounted for 99.4%

of the variation, PC XXII for 5.4% and PC XXIII for 2.2% (Table 7a). For meristic characters, PC I accounted for 97.4% of the variation, and PCII for 2.2% (Table 7b).

3.5 CONDITION FACTOR

The condition factor (K) values for *C. gariepinus* from Ero, Egbe and Ado-Ekiti reservoirs are 0.7 ± 0.2, 0.9 ± 0.3 and 0.7 ± 0.2 respectively. The values are not significantly different from one another.

The condition factor (K) values for *H. odoe* from Egbe and Ado-Ekiti reservoirs are 0.008 ± 0.002 and 0.74 ± 0.04 respectively. The values are significantly different from each other.

DISCUSSION

Clarias gariepinus from the three reservoirs

Clarias has a wide spread distribution and adapted to Nigeria and Africa. The cat fishes from the *Clariidae* are not only used as important economic species but also as invasive species; it was noted that in most of the habitats where *Clarias gariepinus* has been introduced due to their high predatory nature along with Omni-voracity and prolificacy, the species used to impose a great threat to the nature fishes. The used of predatory fish species such as *Clarias gariepinus* in controlling the population of fish species at lower tropic level such as *Tilapia* species, *Orechromis niloticus* through culturing method has been acceptable method worldwide.

Results of the biometric characterization in the present study revealed that *C. gariepinus* obtained from three populations are exhibited morphologically similar, although the level of similarity between them varies across the three populations. The PCA scatter diagram for morphometric characters of *C. gariepinus* showed distinct similarity and relationship. The ANOVA illustrated incomplete homogeneity. The over lapped of data between population of *C. gariepinus* from Ero-reservoir (red), Ado-Ekiti reservoir (pink) and Egbe (blue) as observed on the PCA scatter diagram (fig.1) implies that these populations are phenotypically inseparable (i.e. homogeneity) based on the morphometric characters.

The Cluster analysis (dendrogram) using Rho similarity measure for *C. gariepinus* in the three reservoirs (fig.2), which has a single origin of ancestor, also illustrated the level of homogeneity of *C. gariepinus* from the three populations.

[3] Reported similarities in the morphological composition of *Clarias gariepinus* collected from a fish pond in Emure - Ekiti (controlled population) and Ogbese-River (Uncontrolled population). However, the data obtained in the present study conforms to [10], discussed in their report that PCA scatter diagram using 95% ellipses for the morphometric of wild (Ero-reservoir) and cultured (pond) *Clarias gariepinus* of both genders, illustrated incomplete homogeneity. Despite the level of similarities that exist between *C. geriepinus* from the three reservoirs, some little variation still exist. Variations in body form have important fitness consequent on fish, both in cultured and wild populations [11]. The fish, *C. gariepinus* from the three reservoirs also showed colour differences which might be caused by environmental factors. Specimens obtained from Ero-reservoir were darker than Ado-Ekiti reservoir. Similarly, those obtained from Egbe- reservoir were darker than those from Ero- reservoir.

This may also suggest that the fish specimens examined had made morphological variation to better adjust to their environmental conditions. This variation was also noticed by [12]. They reported that fish specimens obtained from Omo-Reservoir were darker than that of Ogbese - Reservoir, and those obtained from Oluwa-Reservoir were darker than those from Owena-Reservoir.

PCA scatter diagram for meristic characters of *C. gariepinus* from the three populations using 95% ellipses (fig. 3) revealed that *C. gariepinus* from Ero-reservoir (red) and Egbe- reservoir (blue) have homogeneity, while those from Ado-Ekiti reservoir (pink) were morphologically not related.

The PCA loadings for the morphometric characters of *C. gariepinus* from the three reservoirs also illustrated the homogeneity with little variations existed in these populations and indicated the precise trait or character with highest morphometric variation –DFL (0.005304) and gill filament (0.9993) for meristic character (fig. 7 and 8), this gives detailed information of ANOVA. All the studied populations are the strains with more gene flow had occurred among them in their locations. This is the evidenced in the high level of homogeneity reported in this study.

Morealso, this paper also revealed that, *H. odoe* obtained from two populations (reservoirs) showed homogeneity which is phenotypically similar. The PCA scatter diagram for morphometric characters of *H. odoe* (fig.4) showed a distinct similarity and relationship. The complete overlap of data between populations of *H. odoe* from Egbe (blue) and Ado-Ekiti (pink) as observed on the PCA scatter diagram implies that these populations have phenotypically homogeneity based on their morphometric characters. The cluster analysis (dendrogram) using Rho similarity measure for *H. odoe* in the two reservoirs (fig.5), which has a single origin of ancestor, also confirmed the level of homogeneity of *H. odoe* from the two populations. Likewise the PCA scatter diagram for meristic characters of *H. odoe* from the two populations using 95% ellipses also confirmed that *H. odoe* from Egbe (blue) and Ado-Ekiti (pink) have homogeneity as indicated by the overlapping of data (fig.6). The PCA loadings for the morphometric characters and meristic characters of *H. odoe* from the two reservoirs also support that, they exhibited homogeneity with a little variations in these populations and indicated the precise character with the variation DSO (0.005738) loadings and nVC (0.01078) loadings for meristic characters. The two studied populations for *H. odoe* are the same species with more gene flow occurring among them in their locations (Fig. 7 and Table 5a, Fig. 8 and Table 5b).

Condition factor

The mean condition factor (K) of the fish which strongly depend on Fish length for *C. gariepinus* from Egbe was slightly higher than that of Ero and Ado-Ekiti reservoirs populations' sample. And for *H. odoe* from Ado-Ekiti population higher than that of Egbe- population sample. When there is variation in the condition factor from three or two different populations, it suggests that the fish under this study are not from the same source, except *C. gariepinus* from Ado-Ekiti reservoir and Ero- population sample that has the same values.

The condition factor defines the well being of the fish in a particular environment at a time. Fish with higher K values are in a better condition than the fish with lower K values with respect to their lengths [13, 2]. A value of K for *C. gariepinus* from Ero, Egbe and Ado-Ekiti populations, and *H. odoe* from Egbe and Ado-Ekiti populations are lesser than 1. This means that the feeding of *C. gariepinus* from Ero, Egbe and Ado-Ekiti populations and *H. odoe* from Egbe and Ado-Ekiti populations may be inadequate. And this implies that these fish populations may not have been fed to the required level or caught from not well naturally fertilised ecological niche or there is more competition for available food substances in the ecological niche. So, there is need to determine the reasons for better growth and development of:

(i) *C. gariepinus* from Ero, Egbe and Ado-Ekiti reservoirs and

(ii) *H. odoe* collected from Egbe and Ado-Ekiti reservoirs, Ekiti- state, Nigeria.

Fish sufficiently fed had 'K' values equals or greater than 1 while undernourished fish had 'K' less than 1. These results suggest similarity in the morphological composition and the condition factor of both *C. gariepinus* from Ero, Egbe and Ado-Ekiti reservoirs and *H. odoe* from Egbe and Ado-Ekiti populations [14, 2].

CONCLUSION

This study revealed phenotypically homogeneity in both morphometric and meristic characters of *Clarias gariepinus* inhabiting the three different reservoirs of study based on multivariate analysis. Except the meristic characters of *Clarias gariepinus* from Ado-Ekiti reservoir that somehow differ from other two reservoirs. Hence, there should be further genetic tests on this fish species to detect the level of differences from the three reservoirs.

These results also established homogeneity phenotypically in both morphometric and meristic characters of *H. odoe* inhabiting two different reservoirs based on multivariable analysis of the morphometric and meristic characters.

Lastly, these results obtained in this study suggest similarities in the morphological composition and the condition factors of *Clarias gariepinus* and *H. odoe*. There is need to determine the favourable factors of the growth and development of *Clarias gariepinus* and *H. odoe* in the subsequent studies on Ero, Egbe and Ado-Ekiti reservoirs, Ekiti State, Nigeria.

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