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Biometric Characteristics of Sphyraena afra from Coastal Waters of Lagos State, Nigeria

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Abstract
Meristic counts and morphometric measurements were carried out on *Sphyraena afra* from both off Lagos coast (LC) and Lagos lagoon complex (LLC) of Lagos state to evaluate the degree of variation among the populations as this will serve as a reference for sustainable fisheries management in the two environments. Approximately 1249 individuals were sampled from the two water bodies. Nine meristic and 18 morphometric characters on each specimen were investigated. A principal component analysis (PCA) was performed to analyse meristic and morphometric variables. The population of the species among the two water bodies showed little variation in morphometric measurements and meristic counts which did not differ significantly ($P \geq 0.05$). The result revealed that only the first component accounted for the observed variations among the two populations studied and the PCA results showed that lateral line pores (LL) was the only character that shows significant contribution in species delineation. Differences observed in the lateral line pores may be attributed to environmentally induced changes rather than by genetic properties.
Keywords: Meristic, Morphometric, *Sphyraena afra*, Principal component analysis (PCA), Lateral line pores.

Introduction

Sphyraena afra (Barracuda) is an economically important fish species in Nigerian coastal waters where it forms part of the major commercial catch. Barracudas are marine species of the Sphyraenidae Family occurring in tropical and subtropical oceans (30^0N-30^0S). Sphyraenidae includes only one genus, *Sphyraena* with 21 species (Nelson 2006). They are mostly pelagic fish although small species belonging to this family live often near the bottom (Whitehead *et al.*, 1986). They are schooling species occurring in shallow and generally turbid coastal waters over muddy bottom, often ascending estuaries well into brackish waters. Juveniles and adults can be observed travelling in schools during the day. As the fish get older and bigger, they may compete with larger fish like mackerel or even dolphins, depending on their habitat (Paterson, 2000). The occurrence, distribution and behaviour, of the genus *Sphyraena* has been reported by some authors. Relini and Relini (1997) studied the distribution of *S. viridensis* in the Italian shores as well as Balearic and Sardnian waters and reported that the dispersion of this fish species is fast and that more samples of this species will be caught in the future in the middle and North Adriatic sea. Paterson (2000) also studied the occurrence and formation of *S. barracuda* schools in Islands Turks and Caicos. Dulcic and Soldo (2004) reported on the occurrence of the yellow mouth Barracuda *Sphyraena viridensis* in the Adriatic Sea.

Sphyraena afra is fished on a commercial scale using various fishing gears; trawl nets, purse seines, gill nets, trammel nets and longlines. Morphometric study which is a powerful tool for characterizing strains of the same species plays very important role in population assessment and for selection of quality strain of fish species. Morphometric and meristic variations have been used as a method for stock identification of fish species such as *Trachurus mediterraneus* (Turan, 2004), *Limanda ferruginea* (Cadrin and Silva, 2005), *Rastrelliger kanagurta* (Jayasankar *et al.,* 2004), *Megalaspis cordyla* (Sagina *et al*., 2011), *Channa punctatus* (Khan *et al*., 2013), Tilapia *zilli* (Fagbuaro, 2015). Information on stock structure is useful for the development of management strategies that will be helpful in conserving the biodiversity associated with different species, subspecies, stocks and races (Turan *et al*., 2005).

Variation in the right gill rakers of *Schilbe mystus* in Asejire and Oyan Lakes was reported by Ayoade (2011). She found significant differences on the right gill rakers but none between the ten morphometric measurements and other five meristic measurements which she reported might be attributed to environmentally induced changes rather than by genetic properties. Studies carried out on species of genus *Sphyraena* include the work of Jaiswar *et al.* (2004) who studied the morphometric and meristic of Obtuse barracuda *Sphyraena obtusata* from Mumbai (Bombay) water and reported allometric relationship and high degree of homogeneity within the population.

Meristic and morphometric characters were used in this study to evaluate the degree of variation among the populations. Information on the variability of meristic and morphometric characters of this fish species in the Lagos lagoon complex (LLC) and off Lagos coast (LC) could serve as a reference for future sustainable fisheries

management in coastal waters of Lagos state.

Materials and Methods

Study areas

The study area covered coastal waters of Lagos State from Yovoyan in Badagry to Oshoroko beach in Lekki. Seven sampling stations were selected. Yovoyan, Ibeshe, Oshoroko and Orimedu stations were from off Lagos coast (marine) while Badagry Lagoon, Lekki Lagoon and Lagos Lagoon were selected from Lagos lagoon complex (brackish) (Fig. 1). Sampling stations included fishing villages, landing sites and lagoon in the study area. The study area is located between longitude 2º 10´and 3º 45´ and latitude 6º 20´and 6º 30´. This part of the Nigerian coastline covers a distance of approximately 200 km.

Physico- chemical parameters of coastal waters of Lagos state

Surface water samples were collected with 500ml plastic containers from all the stations. Some parameters such as water temperature, hydrogen ion concentration (pH), salinity and dissolved oxygen were measured in-situ while water conductivity was measured in the Physical and Chemical Oceanography Laboratory, Nigerian Institute for Oceanography and Marine Research (NIOMR).

Collection and analysis of specimens

Specimens of *Sphyraena afra* were collected from seven stations from coastal waters between August 2009 and July 2011 using a combination of fishing gears; including trawl nets, purse seines, gill nets, trammel nets and longlines with the help of fishermen. The mesh sizes of the net materials ranged from 2.5 – 6.0 inches depending on the fish sizes. Hook and lines were mainly used to catch large sized fish species. The species was identified with FAO guide.

Measurements

The morphometric data were collected as described by Fischer *et al*. (1981) (Fig.2). Morphometric characters were measured using metre rule, divider and Vernier calliper. They were measured from the left side of the fish. The meristic characters were also determined along side with the morphometric characters (Plate 1) which include counting the following:

Number of dorsal fin rays, number of pectoral fin rays, number of anal fin rays, number of lateral line pores, number of pelvic fin rays and number of vertebrae.

Data analysis

IBM SPSS 20 was used to determine the means and significant difference in the morphometric and meristic features of fish samples in both off Lagos coast (LC) and Lagos lagoon complex (LLC). Principal components analysis (PCA) was used to compare population of individuals from different stations of two water bodies. The ratios of all the parameters pooled together (morphometric and meristic) to standard length for each sampled fish were analysed using PAST version 1.34 software. All data were subjected to scatter plots of Principal Component Analysis (PCA) to produce graphs to visualise relationships.

Results

Physico- chemical parameters of coastal waters of Lagos state.

Average water temperatures ranged between 27.5^{0}C to 31.5^{0}C in LC and 27.5^{0}C to 31.0^{0}C in LLC, dissolved oxygen (DO) ranged between 5.3mg/l to 8.08mg/l in LC and 5.0mg/l to 8.5mg/l in LLC, pH ranged between 6.5 to 8.45 in LC and 4.5 to 8.3 in LLC, salinity ranged between 24‰ to 37‰ in LC and 0.4 ‰ to 13‰ in LLC and water conductivity ranged between 22.05 µS/cm to 48.41µS/cm in LC and between 23.0 µS/cm to 47.4µS/cm in LLC.

Meristic features

The range and mean values of meristic counts of *S. afra* from all the different stations are shown on Table 1. The number of first dorsal fin rays, second dorsal fin ray and pelvic fin rays had constant value of 5, 9 and 6 respectively in all the specimens examined. The anal fin ray ranged between 8 and 10 with a mean of 8.55 ± 0.012, while the pelvic fin rays were 5 and one spinous pelvic fin ray. The pectoral fin rays ranged between 10 and 12 with a mean value of 11.82 ± 0.013. All the specimens examined had between 17 and 20 caudal fin rays with a mean of 17.56 ± 0.22. The lateral line pores, number of scales above the lateral line and number of vertebrae ranged from 135 - 150, 20 - 23 and 22 - 23 with mean values of 141.37 ± 0.097, 21.44 ± 0.025 and 22.61 ± 0.01 respectively.

Morphometric features

Table 2 shows the ranges, mean values, standard deviation and variance of morphometric features of *Sphyraena afra* from coastal waters of Lagos state. The standard length ranged from 14.50 to 152.20 cm with a mean value of 32.68 ± 0.25 cm, head length ranged from 3.2 – 9.0 cm (mean 6.72 ± 0.94 cm}, eye diameter ranged from 0.75 – 1.40 cm (mean 1.16 ± 0.14 cm) and caudal peduncle length ranged from 1.6 – 4.3 cm (mean 3.3 ± 0.5 cm). Fig. 3 showed morphometric measurement of *S. afra* from Lagos coast and Lagos lagoon complex of Lagos state. There was no significant difference between the morphometric characters of LC and LLC ($P< 0.05$).

Principal components analysis (PCA)

The Eigen values and correspondent percentage variance of the morphometric and meristic characters of *S. afra* across the two water bodies was shown (Table 3). The Eigen values greater than the jollife- cut off of 0.043416 (Table 3) were considered significant. These values are to show the distribution of variation among the components in the principal component analysis. The visual examination of plots of component 1 and component 2 in morphometric and meristic characters revealed that 97.75% and 0.76% of the components were considered significant (Table 3). With the indicated respective Joliffe cut-off according to Jollife (1986) only the first component (PC1) obtained from components 1 and 2 accounted for the observed variations among the two populations studied. There was general overlap and the level of overlaps from LC and LLC is illustrated in Fig. 4. Table 4 represents the PCA loadings between the morphometric and meristic characters measured from the two water bodies. Using a cut-off of 0.4 according to Stevens (1992) the character with significant contribution to the delineation of the species was lateral line pores. This character falls within the cut-off. Principal Component Analysis (PCA) results showed that lateral line pores (LL) was the only character that shows significant contribution in species delineation.

The slight variation detected using PAST software was from lateral line pores which was statistically insignificant ($p<0.05$) in both LC and LLC of Lagos state. The differences observed in the morphometric measurements were insignificant.

Discussion

Variation of some physico chemical parameters of the water bodies could be used to explain the variability of environment. Temperature variation is one of the factors in the coastal and estuarine system which may influence other physico-chemical characteristics, the distribution and abundance of flora and fauna (Soundarapandian *et al.,* 2009). Values obtained for physico chemical parameters in the coastal waters of Lagos state were within the acceptable levels for survival, metabolism and physiology of aquatic organism (Kamran *et al.,* 2003, WHO, 2004). The similar and fairly constant values in the meristic features and morphometric measurements recorded in this work and with the slight variation detected from lateral line pores in the PCA analysis using PAST software which was statistically insignificant ($p<0.05$) in LC and LLC of Lagos state may not be associated with genetic differentiation but by inclusion of environmental factors or their interaction. This is supported by Barbour *et al.* (1982) working on *Ilisha africana* caught off the Nigeria coast. Ayoade (2004) observed slight variation in meristic and morphometric features of *S. mystus* from Asejire and Oyan Lake and reported that the variation could be said to be morphological which reflected environmental differences. Ajado and Edokpayi (2003) also made observation that there was no significant difference in the morphometric characteristics of *Clarias gariepinus* from River Niger and Badagry Lagoon and reported identical numbers of vertebrae and pelvic fin rays. They reported that environmental factors did not appear to have considerable influence on vertebral count of some fish. Morphometric relationship among the clariid fishes of the Lake Victoria Basin, Tanzania was investigated with 27 morphometric measurements and 6 meristic counts using PCA. The result showed that morphometric augmented by multivariate analysis amalgamated the clariid into 3 groups (Nwita, 2015). In this present study, the differences observed in the morphometric measurements, (eye-diameter, pre-anterior dorsal length, head length, pre posterior dorsal length, pelvic length, pre pectoral length) were insignificant. The observed similarities in the meristic and morphometric features between the Lagos coast and Lagos lagoon complex suggest that the fish samples belong to the same species and no morphological variability observed in the two water bodies. 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 program. The data obtained from this study will serve as template in systematic study and taxonomy of this species and other non-related fishes. This information would contribute to a better understanding of the taxonomy of *Sphyraena afra.*

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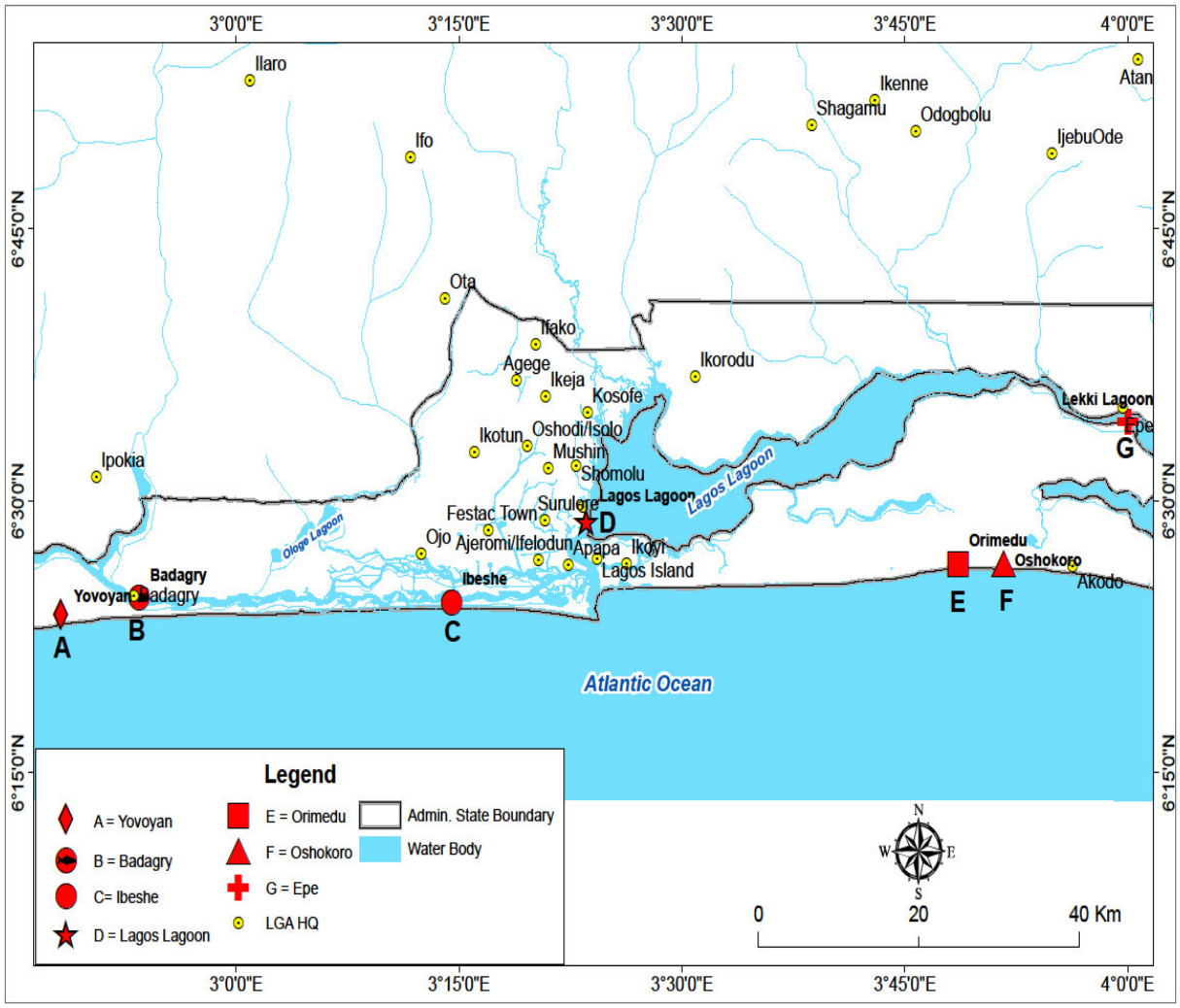

Fig 1. The map of coastal waters of Lagos state showing sampling stations

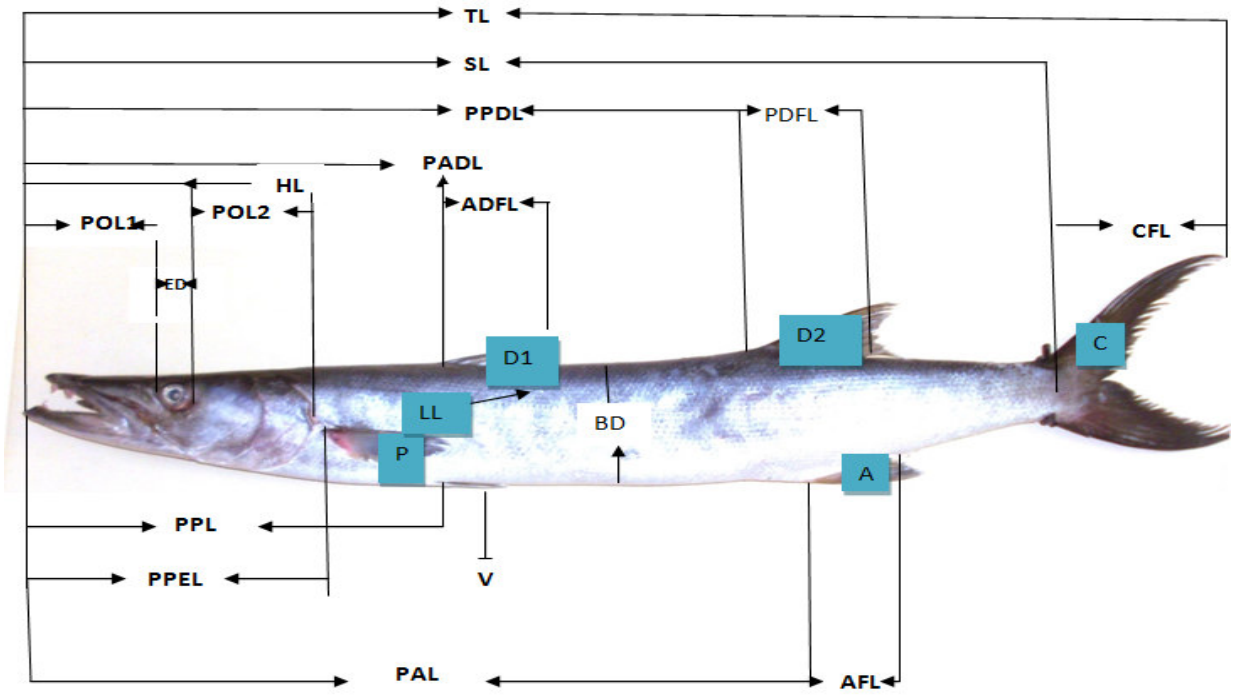

Fig 2. *Sphyraena afra* showing morphometric and meristic features

Legend

TL - Total Length
POL- Pre Orbital Length
SL- Standard Length
PADL-Pre Anterior Dorsal Length
PPDL-Pre Pectoral Dorsal Length
PAL- Pre Anal Length
ADFL- Anterior Dorsal Fin Length
PDFL- Posterior Dorsal Fin Length
PPL-Pre Pelvic Length
PPEL- Pre Pectoral Length
DFL - Dorsal Fin Length
POL2- Post Orbital Length
CFL- Caudal Fin Length
AFL-Anal Fin Length
HL- Head Length
ED- Eye Diameter
BD- Body Depth
D1-1ST Dorsal Fin Ray
A- Anal Fin Ray
C- Caudal Fin Ray
V- Pelvic Fin Ray
P- Pectoral Fin Ray
LL- Lateral Line Pores
D2- 2nd Dorsal Fin Ray

Table 1. Meristic features of *Sphyraena afra* from coastal waters of Lagos state

Meristic characters	Range	Mean± SE	Standard deviation	Variance
First dorsal fin ray	5	5	0.000	0.000
Second dorsal fin ray	9	9	0.000	0.000
Anal fin ray	8-10	8.55±0.012	0.503	0.253
Pelvic fin ray	6	6	0.000	0.000
Pectoral fin ray	10-12	11.82±0.013	0.539	0.291
Caudal fin ray	17-20	17.56±0.22	0.530	0.281
Lateral line pores	135-150	141.37±0.097	3.99	15.88
Scales above the lateral line	20-23	21.44±0.025	1.025	1.052
Number of vertebrae	22-23	22.61±0.01	0.489	0.239

Table 2. Mean Morphometric features of *Sphyraena afra* from coastal waters of Lagos state

Morphometric characters	Range (cm)	Mean±S.E (cm)	Standard deviation	Variance
Total length (TL)	17.60- 183.30	39.74±0.32	12.9964	168.91
Standard length (SL)	14.5- 152.2	32.68±0.25	10.3797	107.74
Pre- anterior dorsal length (PADL)	5.9-65.3	14.31±0.11	4.2998	18.49
Pre- posterior dorsal length (PPDL)	11.50 –116.00	23.25±0.18	7.3669	54.27
Pre anal length(PAL)	12.2-116.4	24.02±0.19	7.8870	62.21
Pre- pelvic length (PPL)	1.6 – 73.6	13.53±0.13	5.1633	26.66
Pre pectoral length (PPEL)	1.10 – 64.2	10.82±0.09	3.5478	12.59
Anterior dorsal fin length (ADFL)	1 – 22.0	2.55±0.03	1.2371	1.53
Posterior dorsal fin length (PDFL)	1.4 – 23.0	3.14±0.03	1.2359	1.53
Pre orbital length (POL1)	1.00 – 25.00	4.98±0.05	1.9153	3.67
Post orbital length (POL2)	1.10 – 30.00	5.96±0.05	2.19061	4.44
Caudal fin length (CFL)	2.0 – 28.00	7.07±0.08	3.1116	9.68
Anal fin length (AFL)	1.10 – 12.8	2.86±0.03	1.2489	1.56
Head length (HL)	1.5 – 52.30	10.18±0.07	2.8928	8.37
Eye Diameter (ED)	1.00 – 11.8	1.59±0.02	0.6252	0.39
Pre maxillary tooth plate width (PMW)	0.9 – 7.9	1.65±0.02	0.6491	0.42
Vomerine tooth plate width (VMW)	1.2 – 23.4	5.07±0.04	1.7761	3.15
Body depth (BD)	2.7 – 32.5	6.05±0.05	2.0785	4.32

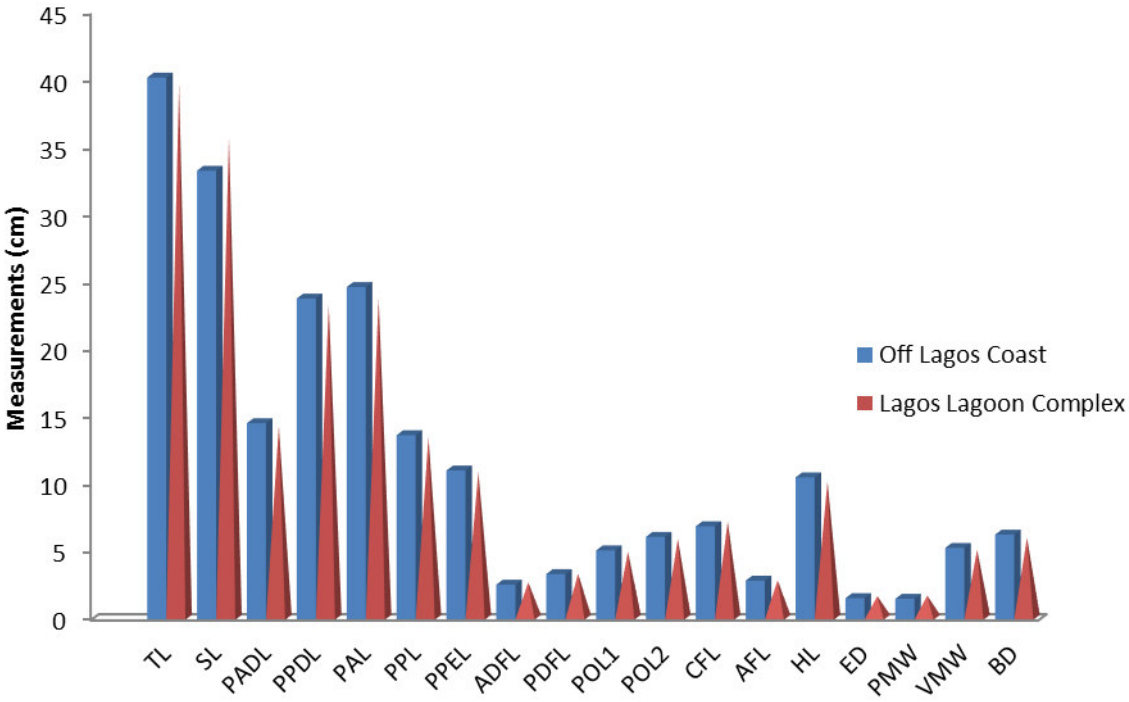

Fig 3. Morphometric measurements of *Sphyraena afra* from coastal waters of Lagos state

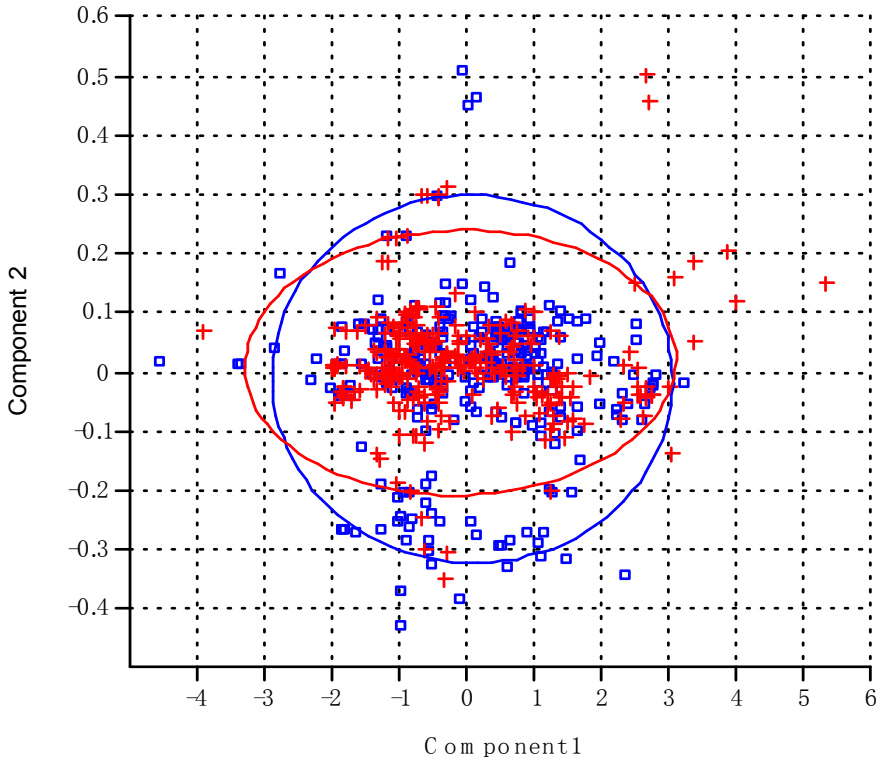

Fig 4. Relationship in morphometric and meristic features of *Sphyraena afra* in coastal waters of Lagos state.

Keys: □ – Morphometric and meristic characters of fish specimens captured from LC

+- morphometric and meristic characters of fish specimen from LLC

Table 3. Eigen value/ percentage variance of morphometric and meristic feature of *Sphyraena afra* in coastal waters of Lagos state

PC	Eigen value	%variance
1	1.57625	97.746
2	0.0122503	0.75966
3	0.0057321	0.35546
4	0.0049568	0.30738
5	0.0029661	0.18393
6	0.0020388	0.12643
7	0.0019906	0.12344
8	0.0016704	0.10359
9	0.0013847	0.08587
10	0.000745	0.046199
11	0.0005717	0.035454
12	0.0004523	0.028051
13	0.0003756	0.023289
14	0.0002714	0.016831
15	0.0002577	0.015978
16	0.0002221	0.013772
17	0.0001897	0.011764
18	0.0001705	0.010571
19	3.89E-05	0.002411
20	3.45E-05	0.002138
21	2.45E-05	0.001522
22	4.97E-06	0.000308
23	4.13E-07	2.56E-05
24	6.68E-18	4.14E-16
25	-6.78E-19	-4.20E-17
26	-1.03E-18	-6.38E-17

Jolliffe cut- off 0.043416

Table 4: PCA loading of Morphometric/Meristic character of *S. afra* in coastal waters of Lagos state.

PC1	Morphometric and meristic characters	PCA loadings
1	HL/SL	0.004016
2	BD/SL	-0.00267
3	ED/SL	0.01251
4	PMW/HL	0.005479
5	CFL/SL	0.003878
6	VMW/SL	0.00273
7	PADL/SL	0.00667
8	PPDL/SL	0.009652
9	PAL/SL	0.01114
10	PPL/SL	0.003242
11	PPEL/SL	0.00885
12	ADFL/SL	-0.00357
13	PDFL/SL	6.93E-05
14	POL1/HL	0.003404
15	POL2/HL	0.003404
16	TL/SL	-0.00938
17	AFL/SL	0.004082
18	FC/SL	0.03331
19	DF/SL	0.05995
20	AF/SL	0.0562
21	PF/SL	0.07992
22	PEL/SL	0.03997
23	CF/SL	0.1167
24	**LL/SL**	**0.9627**
25	SAL/SL	0.1433
26	VET/SL	0.15

PC1