Aspects of the Biology of Sickle fin mullet, *Liza falcipinnis* (Valenciennes, 1836). from Badagry creek, Lagos, Nigeria

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Abstract: Biologic aspects of Sickle fin mullet, *Liza falcipinnis* were investigated in Badagry creek, Lagos, Nigeria between July 2006 and June 2007. *L. falcipinnis* is a commercially valued fish species in Nigeria and West African sub-region. Its importance lies in its fisheries especially in the creeks, estuaries and lagoons. Of recently the catch per unit of effort of this and other fishes have reduced drastically due to poor management of the water resources. Overfishing, household and industrial discharges, logging and dredging activities and other human activities are the contributory factors. Four hundred and forty-four (444) individuals of his species were collected with gill and cast nets at depths between 0 and 25 m. The morphometric and biometric data were collected from the fish. Length frequency analysis and length-weight relationships (LWR) were determined from the data. Diet composition of the fish was determined by macroscopic and microscopic examinations of the stomach contents. Sex and stages of maturity were ascertained by naked eye examination of the gonads. Specimens that were classified as immature were those with gonads whose sex can not be ascertained as males or females. The morphometric data included: 6-12 mm for ED, 18-49 mm for HL, HD was 13-45 mm, and BD, 22-85 mm. The fish ranged from 100-290 mm TL and weighed between 12.0 and 241.0 g BW respectively. The fish matured at 116 and 121 mm TL for males and females respectively, both ripe at 90 mm TL. The LWR was LogW=-3.63+2.31LogL(r=0.79) for immature, LogW=-3.91+2.48LogL(r=0.87) for males and LogW=-4.89+2.91LogL(r=0.89) for females. The mean K values were 7.9 x 10^{-4} (immature), 8.7 x10^{-4} (males) and 9.7 x10^{-4} (females). The species consisted of 123 juveniles, 173 sub-adults and 148 adults, constituting 27.72, 38.96, and 33.33% of the fish population respectively. The diet included 13 different food organisms that were grouped into 4 categories and 7 classes. The species was both detritus and benthic feeder; an herbivore that fed on algae, a piscivore by feeding on fish and possessed carnivorous tendency. There were variations in numbers and occurrences of these items in the stomachs of fish. Its diet varied from the microscopic algae to macroscopic fish fry. The overall sex ratio was 1 male: 1.13 females (X^2=11.36>$X^2_{1, 0.05}$ =3.84). The population was in favour of females. There was a significant departure from the theoretical 1male:1female. The mean GSI values were 0.382±0.20 for and 0.737±0.23% for females. In the present study, the morphometric measurements, growth patterns, diet composition, and aspects of reproductive biology of *L. falcipinnis* were investigated for the purpose of providing biological data as baseline data for carrying out further investigations on the ecology of this species, and management and conservation of the fisheries resources in Badagry creek.
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1.0 Introduction

Sickle fin fish, *Liza falcipinnis,* is a bony fish of the family Mugilidae, Class Actinopterygii (ray-finned fishes) and the Order Perciformes. The family consists of 17 genera and 80 species. Common genera include: *Chelon, Liza, Mugil* and *Valamugil*. *Liza dumerilli* (grooved mullet), *L. grandisquamis* (large-scale mullet), *L. argentea* (flat-tail mullet) and *L. triscuspider* (stripped mullet) are the common members of the genus *Liza*. Aspects of the biology of *Mugil cephalus* - a related species was investigated by Lawson and Jimoh (2010) in Lagos lagoon, Nigeria. Mullets are very successful as a result of their feeding habits and the abundance of their food (Kurian, 1975, Payne 1976). They are mostly benthic feeder which grow and thrive well on diatoms, aquatic macrophytes, benthic rotifer, larvae, fish eggs, cyclopods, copepods, organic detritus and small algal cells which the fish scoop up when swimming at an angle to the bottom, running their mouth through the sediments. The larger particles retained by their fine gill-rakers and then ground up in their gizzard-like stomachs. Mugilids are widely distributed in all tropical and temperate seas of world.

They are demersal and chiefly marine or coastal (Scheneider, 1990) and brackish water; some like *Liza abu* are found in freshwater (Thompson, 1990) and estuaries at shallow depth (less than 20m) for feeding purpose. Travel in schools and feed on fine algae, diatoms, and detritus of bottom sediments (Diouf, 1996). Reproductively, most members of this family are non-guarders. Some of the reviews on this species include that of Fischer et al. (1981) on taxonomy, Akpan and Ubak (2005) on its trophic ecology in the Cross River estuary in Nigeria, Akinrotimi et al (2010) on its occurrence and distribution in Buguma creek, Niger delta. King (1983) on food and feeding habits in Bonny River. Okoro et al (2010) discussed its quality assessment under different storage conditions. In the Bonny River the species was described as a detritus-algivore-deposit feeder (King, 1983). Information on the species is very scanty in south western part of Nigeria, especially in Lagos lagoon system where it is of commercial value and sold for as much as $10/kg. This couple with high rate of its depletion of resources of our water body due to overfishing activities of fishermen, it is therefore pertinent to carry out investigation that will provide baseline data towards ecology, conservation and sustainability of fishes and fisheries resources in this water body.

2.0 Materials and methods

2.1 Study area: The Badagry creek (Fig. 1) is a long stretch of water body that runs parallel to the Atlantic Ocean in the south; it extends from Lake Nokue near Port-novo, Benin republic to Apapa area of Lagos before opening up into the Atlantic Ocean via Lagos harbour. Along the creeks the major occupation of the inhabitants is fishing, crop farming, and mat weaving. There is diversity of fin and shell fishes in the creek. Fish species such as *Ethmalosa*, *Gobioides*, *Cynoglossus.* and *Pomadasys*, *Pseudotolithus*, *Tilapia*, *Mugil*, *Liza*, *Clarias*, *Selene*, *Macrobranchum* and *Callinectes* are common in Badgry creek. Reviews on fishes and fisheries of Badagry creek include that of Solarin and Kusemiju (1991), Lawal-Are and Kusemiju (2000), Chukwu and Kuton (2001), Lawal-Are (2001), Ajado and Edokpayi (2003), Kumolu-Johnson (2004), Akintola (2007), Soyinka et. al (2010). Of the eight (8) species that were identified on the Nigerian coast by Sivalingam (1975) *Liza falcipinnis* was the most abundant.

Figure. 1 Map of Lagos State, Nigeria showing Badagry creek

2.1 Collection of specimens.

Study was conducted in the Badagry creek, Lagos, Nigeria between July 2006 and June 2007. A total of 444 individual fish specimens of sickle fin mullet, *L. falcipinnis* were caught during this period. The fish were caught by cast nets (mesh sizes: 12-22mm) for collecting fish from 0-5 m depths and gill nets of 20- 45 mm mesh size for specimens at depths exceeding 5 m. Diurnal collections from the gears were carried out daily through the services of motorized local artisanal fishermen. The specimens were preserved in 9% formaldehyde solution prior laboratory analyses.

2.2 Laboratory procedures and data collections.

In the laboratory morphometric and biometric data of the specimens were recorded. Data included the eye diameter, ED (a vertical measurement of the distance or length of eye orbit), head depth, HD (a vertical measurement of the deepest part of head region), head length, HL (a longitudinal measurement of the distance between the snout and a point immediately behind the operculum) and body depth, BD (a measure of the deepest part of the body, i.e. a measure of vertical distance between dorsal and pelvic fins base), total length, TL (distance between snout and the tip of caudal fin) and body weight (W) measurements. The lengths were measured to the nearest 1 mm and weighed to the nearest 0.01g.

Distribution and occurrence of the fish in Badagry creek were based on their size and maturity. The sizes were categorized as juveniles, sub-adults and adults and maturity classified as immature, males and females (Lawson, 1998).

The analysis of the length frequency data was used to determine the size modal distribution over the period of study. Histograms were obtained from the distribution.

The length-weight relationships (LWR) were expressed as: $W=aL^b$ and represented linearly by logarithms transformation: LogW = Loga+b LogL. Parameters a and b were estimated by the least squares regression method, W and L were fish body weight and Total length respectively (Bagenal and Tesch, 1978). Confidence intervals of 95% were calculated for b to see if these were statistically different from 3. The Fulton's equation was used to calculate the condition factor (K) for individual fish: as $K= 100.W.L^{-3}$ (Le Cren, 1951). This factor was used to compare the condition, fatness or well-being of the fish.

The diet composition of this fish was carried out by opening up stomachs and their contents examined under binocular microscope. The contents were sorted and classified to generic levels. Their analyses followed that of Hyne (1950), Hyslop (1980) and Blays and Eyeson (1982a).

Sexes were determined by naked eye examination of gonads, specimens that were classified as immature were those whose gonads could not be differentiated macroscopically as males or females. Sex ratios were tested with Chi squared analyses (X^2).

Gonadosomatic index (GSI) of this fish was expressed a percentage of gonad weight (GW) to body weight (BW). Thus:

$GSI= GW . BW^{-1}.100\%$

Statistical package for social sciences (SPSS) version 9 was used in this study.

3.0 Results

3.1. Morphometric measurements in *L. falcipinnis*

In the present study, data on the morphometric features of *L. falcipinnis* are presented in Table 1. Female fish exhibited better morphometric measurements than its males or immature counterparts. The eye diameter varied between 6 and 12 mm, the means were 7.14±0.94, 7.65±0.94 and 7.97±0.99 mm for immature, males and females respectively. The head length measurement ranged from 18-49 with mean.

Table 1. Morphometric measurements in *L. falcipinnis* from Badagry creek, Nigeria

Morphometric measurements	Immature (n=118)			Males (n=153)			Females (n=173)		
	Range		Mean± SE	Range		Mean± SE	Range		Mean± SE
	Min	Max		Max	Max		Min	Max	
Eye diameter* (ED)	6	9	7.14±0.94	6	12	7.65±0.94	6	12	7.97±0.99
Head length* (HL)	18	34	25.86±3.69	20	49	31.47±5.09	19	49	31.90±5.81
Head depth* (HD)	13	29	22.28±3.16	16	37	26.59±3.95	14	45	27.19±4.21
Body depth* (BD)	22	38	30.59±3.26	23	85	35.85±6.17	24	54	36.4±5.37
Total length* (TL)	100	176	147.83±12.29	115	260	172.3±23.46	121	290	176.98±28.13

*measurement in millimeters

3.2. Length frequency analysis.

Fish total length measurements were in ten (10) modal classes (cohorts) which showed a uni-modal distribution of fish in Badagry creek (Figure 2). The cohorts varied from 109.5 to 289.5 mm TL. The modal length was 169.5 mm TL with frequency of 38.25% of the fish population. The modal distribution skewed more to the left. There was large number of fish between 109.5 and 189.5 mm TL than between 209.5 to 289.5 mm TL cohorts. Age 0-1^{+} was obtained from the modal distribution of length frequency histograms values of 25.86±3.69, 31.47±5.09, and 31.90±5.81mm respectively for immature, males and females. However, head depths were between 13 and 45 mm, the means were 22.28±3.16, 26.59±3.95, and 27.19±4.21 mm. Body weight measurements varied from 22-85 mm, the mean values were 30.59±3.26, 35.85±6.17, and 36.4±5.37 mm for immature, male and female specimens. The mean total length measurements were 147.83±12.29 for immature, 172.3±23.46 for males and 176.98±28.13 for females.

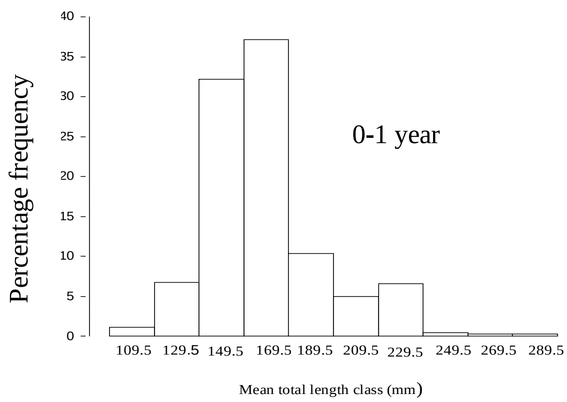

Figure 2. Length frequency histograms in *L. falcipinnis* from Badagry creek, Nigeria

3.3. Length-weight relationships.

Length-weight relationships of *L. falcipinnis* were expressed as follow:

3.3.1. Immature:

Immature specimens varied between 100 and 170 mm (mean=147.83±12.28 mm) TL and weighed from 12 to 38.9 g (mean= 25.66±6.24 g) BW. The log transformation of the LWR is presented in Figure 3 and expressed as:

LogW=-3.63+2.31LogL (n=118, r=0.79)

3.3.2. Males:

The TL measurements of male specimens ranged from 116-260 mm (mean=172.30±23.46mm), weighing 13.2-142.9 g (mean=45.47g±19.85 g) BW. The LWR is presented in Fig. 4 and expressed as:

LogW=-3.91+2.48LogL (n=153, r=0.87)

3.3.3. Females:

Those classified as female specimens were between 121 and 290 mm (mean=176.98±28.12 mm) TL and body weights from 17.8 – 241 g (mean= 53.03±32.9 g) respectively. The length-weight relationship (Fig. 5) is expressed as:

LogW=-4.85+2.91LogL (n=173, r=0.89)

Positive allometric growth (b) existed among the fish. High correlation values of b=2.31, 2.48 and 2.91 were exhibited by the immature, males and females respectively. High regression coefficient values of r =0.79, 0.87 and 0.89 were exhibited respectively by immature, male and female specimens. The b and r values were exhibited better in females than in immature and male specimens.

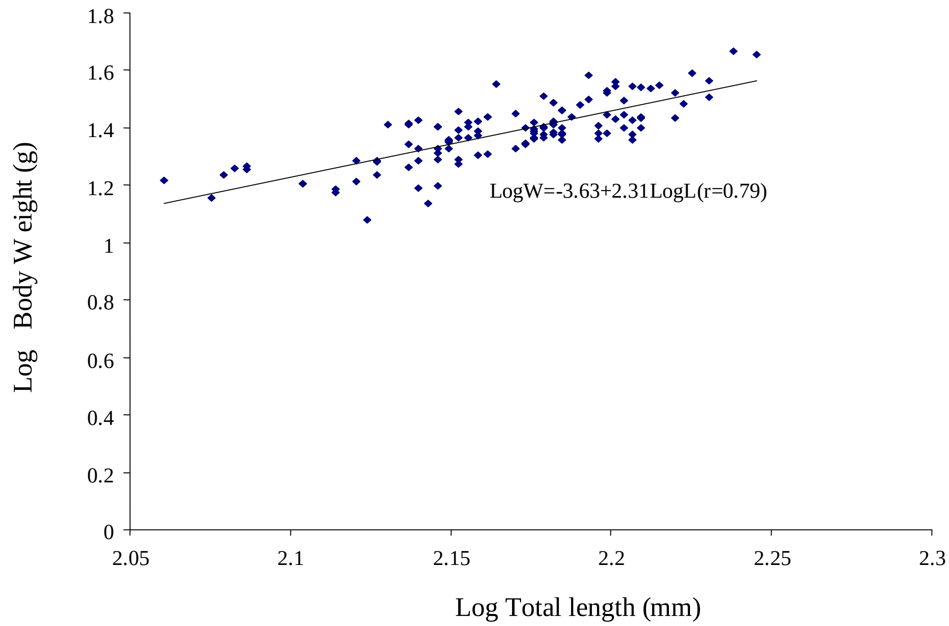

Figure 3. The Log transformation of length-weight weight relationship in *L. falcipinnis* from Badagry creek, Nigeria.

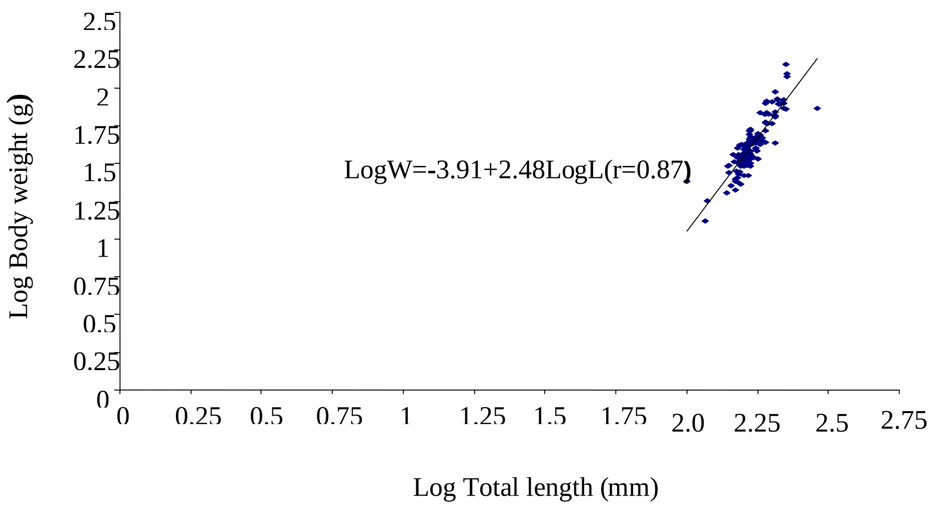

Figure 4.The Log transformation of length-weight relationship in males *L. falcipinnis* from Badagry creek, Nigeria

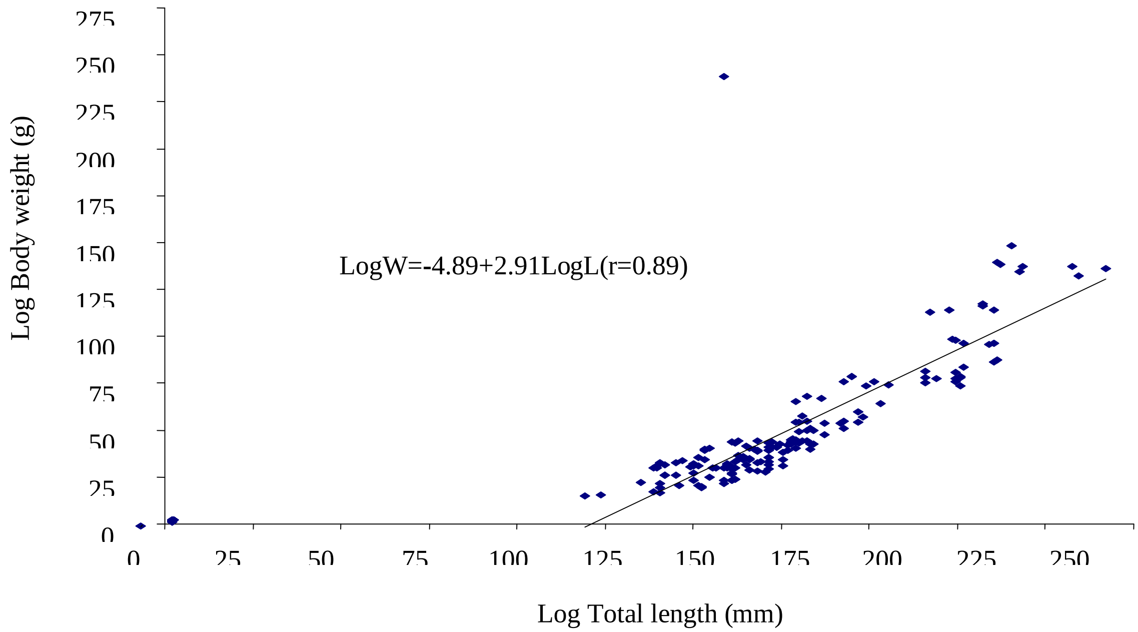

Figure5. The Log transformation of length-weight relationship in females *L. falcipinnis* from Badagry creek, Nigeria.

3.4. Condition factor (K)

There were variations in the mean condition (K) factors in *L. falcipinnis* from Badagry creek (Table 2). K value in immature specimens were $5.1x10^{-4}$ - $1.1x10^{-3}$ (mean= $7.91x10^{-4}$±$7.3x10^{-5}$); in males, $4.9x10^{-4}$ - $2.4x10^{-3}$ (mean=$8.67x10^{-4}$±$5.9x10^{-5}$); and in female specimens from $6.1x10^{-4}$ - $1.3x10^{-3}$ (mean= $9.7x10^{-4}$±$1.4x10^{-4}$) g/mm^3. K values were higher in female fish than in immature and males.

Table 2. Condition factor (K) * in *L. falcipinnis* from Badagry creek, Nigeria.

Sex	Sample size	Range(g/mm^3)		Mean K-values (g/mm^3)
		Min	Max	
Immature	118	$5.1x10^{-4}$	$1.1x10^{-3}$	$7.9x10^{-4}$
Males	153	$4.9x10^{-4}$	$2.4x10^{-3}$	$8.7x10^{-4}$
Females	173	$6.1x10^{-4}$	$1.3x10^{-3}$	$9.7x10^{-4}$

3.5. Distribution and growth patterns in *L. falcipinnis*

The distribution patterns (Table 3) of *L. falcipinnis* in Badagry creek composed of 123 juveniles, 178 sub-adults and 148 adults from 100 immature, 160 male and 184 female specimens.

3.5.1. Juveniles:

A total of 27.72% of the specimens were juveniles. They ranged between 100 and 154 mm TL and weighed from 12.0-43.0 g BW. LWRs of the maturation stages are presented as:

Immature: Log W=-2.694+1.88LogL (n= 67)
Males; Log W=-4.392+2.70LogL (n=23)
Females: Log W= -4.167+2.61LogL (n= 33)

Table 3. Biometry distributions in *L. falcipinnis* from Badagry creek, Nigeria

Size group	Maturity	Sample size	Total length (mm)			Body weight (g			LWR LogW=Log a+b Log L
			Range			Range			
			min.	max.	Mean±SE	min.	max.	Mean±SE	
Juveniles	Immature	67	100	154	143.08±10.84	12.0	35.7	23.16±4.38	LogW=-2.694+1.88LogL
	Males	23	116	154	146.04±10.09	13.2	41.6	29.02±7.18	LogW=-4.392+2.70LogL
	Females	33	121	154	145.46±7.68	17.8	43.0	30.20±7.17	LogW= -4.167+2.61LogL
Sub-Adults	Immature	33	155	170	161.06±3.95	22.7	38.9	30.06±4.76	LogW=-2.662+1.87LogL
	Males	69	155	172	163.94±4.44	23.0	53.2	37.53±6.12	LogW=-5.834+3.0LogL
	Female	71	155	174	164.10±4.87	24.1	151	40.29±26.88	LogW= -4.615+2.89LogL
Adult	Immature	0	0		0	0		0	0
	Males	68	170	260	194.07±21.16	33.9	142.9	63.93±22.17	LogW=-4.956+2.96LogL
	Females	80	171	290	201.67±23.98	42.8	241.0	77.34±30.51	LogW=-3.656+2.37LogL

LWR= Length weight relationship, b=slope, a=constant, r=regression coefficient, W=fish body weight, L=fish total length

3.5.2 Sub-adults:

38.96% specimens of the total catch were classified as sub-adults, measuring between 155 and 174 mm TL and weighed 22.7-151 g BW. The LWRs are given as:

Immature: LogW=-2.662+1.87LogL (n= 33)
Males: LogW=-5.834+3.0LogL (n= 69)
Females: LogW= -4.615+2.89LogL (n=71)

3.5.3 Adults:

Of the total catch, 33.33% were adults, varying in size from 170-290 mm TL for specimens, weighing between 33.9 and 241g BW respectively. The LWRs are expressed as:

Males: LogW=-4.956+2.96LogL (n=68)
Females: LogW=-3.656+2.37LogL (n= 80)

Immature specimens were not represented among the adults.

The differences in mean TL and BW measurements across the groups were not significantly different ($p \geq 0.05$). The values of b were higher in the mature fish than immature and growth exponent, b was positively allometric. The sub-adult males exhibited an isometric growth pattern (b=3).

The monthly distribution of *L. falcipinnis* (Table 4) showed all year presence of this species in Badagry creek. Of 444 individual fish, highest catch of 11.71% was in October 2006 and least occurred (4.96%) in March 2007. The percentages of occurrence were 26.58, 34.46 and 38.96% for immature, males and females respectively. The immature fish was least abundance (0.45%) in January, February and March 2007 and most abundance (4.96%) in August 2006. In males, occurrence ranged from 1.58 in August 2006 to 5.63% in July 2006. The monthly catch for females was least (1.35%) and highest (4.72%) in April 2007 and October 2006 respectively.

Table 4. Monthly occurrence in *L. falcipinnis* from Badagry creek, Nigeria (July 2006-June 2007)

Year	Month	Number of Immature	Number of Males	Number of Females	Sample size
2006	July	10 (2.25)	25 (5.63)	14(3.15)	49(11.04)
	August	22(4.96)	7 (1.58)	16(3.60)	45(10.14)
	September	17 (3.83)	12(2.70)	17 (3.83)	46(10.36)
	October	11(2.48)	20 (4.51)	21(4.72)	52(11.71)
	November	5(1.13)	11(2.48)	13(2.93)	29(6.53)
	December	3(0.67)	12(2.70)	19 (4.28)	34(7.66)
2007	January	2 (0.45)	10 (2.25)	13(2.93)	25 (5.63)
	February	2(0.45)	12 (2.70)	10(2.25)	24(5.41)
	March	2(0.45)	9(2.03)	11(2.48)	22(4.96)
	April	18(4.05)	8 (1.80)	6 (1.35)	32(7.20)
	May	16 (3.60)	13(2.93)	13(2.93)	42(9.46)
	June	10 (2.25)	14(3.15)	20 (4.51)	44(9.91)
Total (Percentage)		118 (26.58%)	153 (34.46%)	173 (38.96%)	444

Figures in parentheses represent percentages

3.6. Diet Composition of *L. falcipinnis.*

Diet composition of *L. falcipinnis* (Table 5) comprised 13 food organisms classified into 4 categories, and 7 taxonomical classes. A total of 53, 772 food items were encountered in 444 stomachs. No empty stomach was encountered in this study. Algae were the only representatives of plant with diatom and filamentous algae as their representatives. The invertebrates ere represented by protozoan, crustaceans, nematode, and chaetognaths. Fish was a lone representative of the vertebrates.

Detritus included decayed organic matter and sand grains. The most eaten category of food was detritus. Of this sand grains constituted 35.17 % by number, occurring in 91.44% stomachs and decayed organic matter was 28.94 by number and 49.10% by occurrence.

Second most eaten category was protozoa, which was represented by *Radiolaria* (contributing 8.50 by number, 17.52% by occurrence), *Tintinopsis* (0.004 by number, 1.35 by occurrence) and foraminfera (9.55 by number, 22.52% by occurrence). Of the algae, diatoms were preferred to dinoflagellates by the species. The least eaten items were nematode, arrow worm (*S. sagitta*) and fish fry which constituted 0.28, 0.05 and 0.09 by number and occurring in 33.33, 0.68 and 11.49% of the stomachs respectively.

Table 5: Diet Composition in 444 stomachs of *L. falcipinnis* from Badagry creek, Nigeria

Category	Classes	Food items	Numerical method		Occurrence method	
			Number	%	Number	%
Plant	Algae	Diatom (*Coscinodiscus*)	8321	15.48	162	36.49
		Dinoflagellates	113	0.21	74	16.67
Invertebrates	Protozoa	Radiolarian *(Radiolaria)*	4572	8.50	78	17.52
		Tintinnid *(Tintinopsis sp)*	22	0.04	6	1.35
		Foram *(Foraminifera)*	5134	9.55	100	22.52
	Crustacea	Crab (*Callinectes)*	128	0.24	100	22.52
		Copepod (*Calanus finmarchicus)*	751	1.40	100	22.52
		Shrimp, *Penaeus notialis*	33	0.10	9	2.03
	Nematoda	Round worm	150	0.28	148	33.33
	Chaetognatha	Arrow worm, sagitta sagitta	29	0.05	148	0.68
Vertebrates	Bony fish	Fish frys	47	0.09	51	11.49
Detritus	Detritus	Organic matter	15, 560	28.94	218	49.10
		Sand grains	18, 912	35.17	406	91.44
			53772*		444	

* sum of all food items encountered in 444 stomachs,

3.7. Sex Ratio

In the present study, 153 male and 173 female specimens were caught representing 34.46 and 38.96% of the fish population respectively, giving the overall sex ratio of 1male:1.13 females (Table 6). A Chi–square revealed a significant departure from the theoretical 1male to 1 female ratio (X^2 =11.36 > $X^2_{1,\ 0.05}$=3.84). Sex ratios were generally in favour of females except in July (1:0.56), February (1:0.83), and April (1:0.75) which were in favour of males. In May it was 1 male: 1 female ratio.

Table 6: Sex ratio in *L. falcipinnis* from Badagry creek, Nigeria

Year	Month	No. of Males	No. of Females	Sex ratio	X^2
2006	July	25	14	1:0.56	3.10
	August	7	16	1:2.29	3.52
	September	12	17	1:1.42	0.86
	October	20	21	1:1.05	0.02
	November	11	13	1:1.18	0.16
	December	12	19	1:1.58	1.58
2007	January	10	13	1:1.30	0.39
	February	12	10	1:0.83	0.18
	March	9	11	1:1.22	0.2
	April	8	6	1:0.75	0.29
	May	13	13	1:1	0.0
	June	14	20	1:1.43	1.06
	Total	153	173	1:1.13	11.36

3.8 Gonadosomatic Index

In the Badagry creek, the GSI values of males ranged between 0.12 and 0.77% with a mean value of 0.30±0.30%. The female GSI values ranged from 0.07% to 6.52% with a mean value of 0.70±1.42% obtained. Gonad weight–total length relationships in *L. falcipinnis* in the Badagry creek are presented in Figures 6 and 7. The regression coefficient (r) differed with sex. Males have a higher value (r=0.70) than females (r=0.25), there was an increase in gonad weights (testes/ovaries) with corresponding increase in fish total lengths.

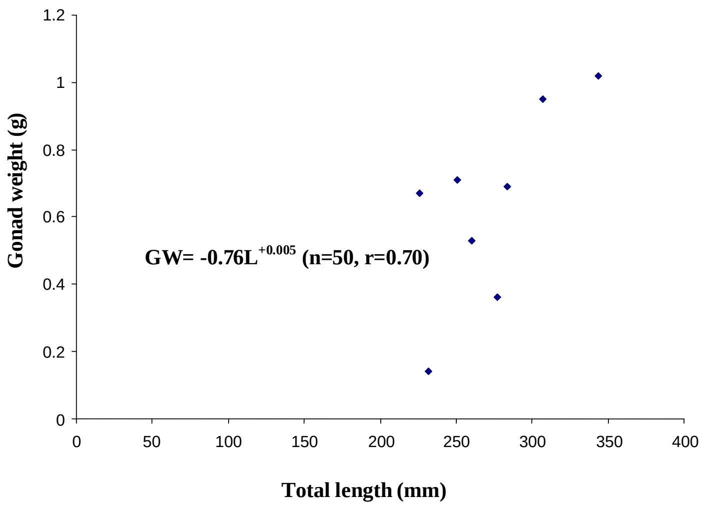

Figure 6: Scatter diagram showing the gonad weight – total length relationship in males *L. falcipinnis* from Badagry creek, Nigeria

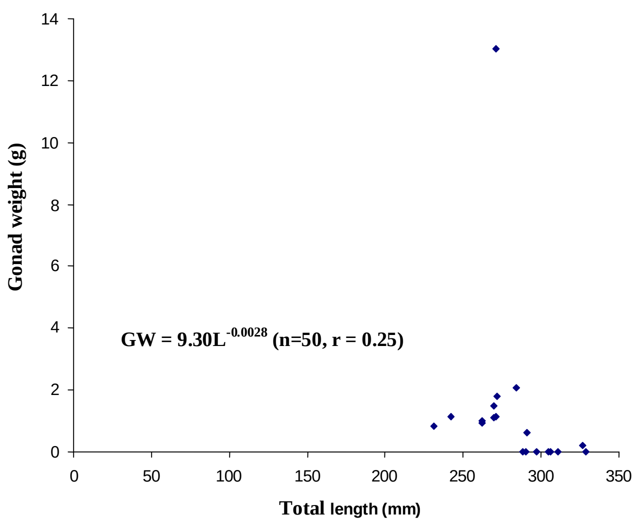

Figure 7: Scatter diagram showing the gonad weight-total length relationship in females *L. falcipinnis* from Badagry creek, Nigeria

4.0 Discussion

The morphometric measurements among the populations of *Liza falcipinnis* in Badagry (Table 1) did show some variations, however, these variations were not significantly different (P≥0.05) enough to make a submission that the species was genetically or morphologically different. A research programme at molecular level of analysis (e.g. Randomly Amplified Polymorphic DNA (RAPD) primers, RAPD markers) may provide better or more precise results on genetic and morphological diversities among the populations of this fish in Badagry creek. Data on eye diameter (6-12 mm), head depth (20-22 mm), head length (18-49 mm), head depth (13-45 mm), body depth (22-85) and total length (100-290 mm) may not be fully relied on as determinants for genetic diversity, but their importance in taxonomic characterization, systematic and racial study of this species can not be over-emphasized. The variations across the groups showed females exhibiting higher measurements than male or immature specimens. The molecular analyses need to be conducted further in order to verify this. The measurements obtained in this study were in agreement with those obtained in other teleosts but with variations. The morphomteric measurements varied with species, sex and size of fish and habitats (Marcus, 1982; Ugwumba, 1984; Lawson, 1998).

The length frequency distribution (Figure 2) confirmed the availability of juveniles, sub adults and adults in the creek. The population was dominated by sub adults (149-170mm TL). The length distribution histograms indicated the age of *L. falcipinnis* in the Badagry creek to be 0- 1 year. Age determination and growth studies in fishes using length frequency analyses have attracted attentions of several fisheries biologists. Petersen method makes use of length frequency analysis in determine age of fish. This method is often used in tropical regions due to problems encountered in determine age of fish using hard parts such as spines, opercula, vertebrae and otolith.

In Badagry creek, sickle-fin mullet, *L. falcipinnis* was categorized into juveniles, sub adult and adults, with size range of 100 -290 mm TL and weight of 12 -241(27.46±6.24) g BW (Table 3). There were variations in size across these categories viz: juveniles, 100-154 (148.86±9.54), sub adults, 155-174 (163.03±4.42), and adults, 170-290 (197.87±22.57) mm TL. The body weight measurements were: 12-43.0 (27.46±6.24), 22.7-151 (35.96±12.59), and 33.9-241 (70.64±26.34)g BW respectively. Within the categories except the adults were males and females. Males attained maturity at 116 mm TL (13.2 g BW), while females at 121 mm TL (17.8 g BW). At adults, the fish measured between 170-290 mm TL and weighed from 33.90-241.0 g BW. Females were bigger than males in Badagry creek. The maximum attainable sizes for males and females in this study were 260 and 290 mm TL respectively. Fischer et al. (1981) reported maximum length of 250 mm TL *L. falcipinnis* in Eastern-central Atlantic. Albaret (1992) reported the maximum size of 410mm (FL) while Dankwa and Blay (2005) reported the maximum weight of 262g for *L. falcipinnis*. King (1996) studies on Imo-River estuary, Qua-Iboe estuary, Cross River estuary and Bonny estuary reported between 3.4-29.7cm (TL) and LWR of LogW = 0.0096 + 2.9550 log L for *L. falcipinnis.*

The growth patterns of this species were near isometric with b=2.31 for immature, 2.48 for males and 2.91 for females (Figures 3, 4, and 5), indicating the weights of fish were not too much for their lengths, this may be responsible for its robustness and feebly compressed body, similar to what Grant *et al.* (1977) reported on the Australian mullet. A positive correlation of r=0.79 for immature, 0.87 for males and 0.89 for females were indication of a strong relationship between total length and body weight measurements of the fish, there was increase in body weight with corresponding increase in total length. LWRs are a useful tool for fisheries research because they allow the conversion of growth in length equation to growth equation for use in stock assessment model, allows for the estimation of biomass from length observation, allows an estimate of the condition of the fish and are useful tools for regional comparism of life histories of certain species (Goncalves et al 1996, Diaz et al 2000, Moutopoulos and Stergious, 2000)

Condition factor was very low in this fish and varied with sex (Table 2). The values were higher in females. The variations of K in the fish according to King (1995) may be indicative of food abundance, adaptation to the environment and gonadal development. This study was similar to what Fafioye and Oluajo (2005) reported on non related fish species like Silver catfish (*Chrysichthys walkeri)*, and clupeids (*Ethmalosa fimbriata* and *Ilisha africana)* in the adjacent Epe lagoon in Lagos, Nigeria. However the values were less than 2.9-4.8 that was documented by Bagenal and Tesch (1978) for mature freshwater fish. Low K was suggested by Braga and Gennari (1990) as a period when accumulated fat is in use for spawning while high values indicates a period of increased rate feeding followed by a gradual increase in accumulated fat, suggesting preparation for a new reproductive period. K was closely linked with reproductive cycle of fish by Fagade and Olaniyan (1972), Ugwumba (1990), Aboaba (1993), Saliu (1997). The low K of *L. falcipinnis* in the Badagry creek as we suggested in the present study may be due to ecological and environmental factors and indication of how well the species was in this water body.

Sivalingam (1975) and Dankwa and Gordon (2002) referred to this fish as one of the most widely spread species of mullets. In Badagry creek, the fish were classified as juveniles (100-15 mm TL, n=123), sub-adult (155-174 mm TL, n=173) and adults (170-290 mm TL, n=148). Immature specimens were found among the juvenile and sub adult fish and not adults (Table 3 and 4). The sub adult populations were greater than the juveniles and adults in the creek. Certain physical and chemical parameters determine distribution of fish in water (Hadzley, 1997). Salinity was a major factor that influence the distribution and occurrence of *Liza falcipinnis* and *Liza grandisquamis* from Buguma Creek, Niger Delta (Akinrotimi et al, 2010), and *Mugil cephalus* in Lagos lagoon, Nigeria (Lawson and Jimoh, 2010).

In this study that *L. falcipinnis* foods varied from microscopic items such as diatoms to macroscopic ones such as nematodes and fish fry (Table 5). This is indication that it has advantages of using large aquatic resource to its advantage. Its occurrence all through the year may be due to this reason; the fish was able to shift from one form of food to another depending on the seasons and availability of the foods. Availability of food organisms are often cyclic and may be due to their life histories, climate, or environmental conditions. Seasonal variation in the feeding habits of fish resulting from climatic changes was reported by Moriarty and Moriarty (1973), Ikusemiju (1975), Tuderancea *et al.* (1988). The diet and feeding intensity can vary even during the diurnal cycle (Keast and Welsh (1968), Elliot (1970), Ikusemiju (1975). Presence of plants presumed the species as an algavore or herbivore, while the availability of the invertebrates showed it as a carnivore, fish fry as parts of its diet was an indication of its piscivorous ability. Presence of organic matter and sand grains in reasonable number mean the species was both detritus and benthic feeder. Our findings were in conformity with reviews from Fischer et al. (1981), King (1983), Diouf (1996), Akpan and Ubak (2005), Akinrotimi et al (2010), Lawson and Jimoh (2010), Okoro et al (2010) on diets of mullets. The success of mullets according to Kurian (1975) and Payne (1976) also lies in their feeding habits and the abundance of their food. Presence of detritus (organic matter, and sand grains) in large quantities in the stomachs of the fish does not presume that these items were nutritional better than other food items that that appeared in lesser number. Sand grain has no nutritional property but they might have been picked up along with other food items. Its presence in the gizzard like stomachs may assist the fish in digestion process. Availability of sand grains in the fish is indicative of it been a benthic feeder.

The overall 1male:1.13 females sex ratio in *L. falcipinnis* (Table 6) was not significantly different from the expected and theoretical 1male:1female. The variation was an indication that sex was in favour of females. Sex ratio that favoured females may account for its reproductive success in Badagry creek, large number of females were available to fewer males for reproduction and this may account for its all year presence in Badagry creek. This was strongly supported by Lawson (1991), and Lawson and Jimoh (2010) who reported a 1 male: 1.42 females ratio on the related species, grey mullet (*Mugil cephalus*) in the adjacent Lagos lagoon. Sex ratios in the favour of females were reported in some non related species like *Ethmalosa fimbriata* (Fagade and Olaniyan, 1972; Blay and Eyeson, 1982b) and *Mugil* cephalus (Lawson 1991, Lawson and Jimoh 2010) High percentages of sex ratios in favour of males during the spawning period were reported in *Elop lacerta* (Ugwumba, 1984; Lawson and Aguda, 2010) and *Chrysichthys walkeri* (Kusemiju, 1978) in some West African lagoons. The reasons may be ecological or genetical factors or both. Females were suspected to leave the spawning grounds more rapidly, which may be considered as an adaptation to facilitate preservation of the females or more rapid recovery of gonads (Ozcan and Balik, 2009). Males according to Nikolsky usually predominate in the younger groups because they mature earlier but live less long.

The GSI of *L. falcipinnis* in this study indicated that females had a higher GSI. Between 0.12 and 0.77 (0.30±0.30%) in males and 0.07% to 6.52% (0.70±1.42%) of the body mass were used or converted by the fish for development of gonads. Higher GSI values in favour of females as reported in this study did not differ from reports obtained from other teleosts. The GSI had been used to describe the development of gonads in Pike, *Esox lucius* (Danilenko, 1983). GSI increases progressively with increases in the percentages of ripe individuals towards the spawning seasons (Mohamed 2010). The most common practice for determination of a species spawning season is the establishment of its GSI and the histological examination of the gonads (El-Greisy, 2000; Assem, 2000 and 2003; Honji et al. 2006). Gonad weight and total length measurements were positively correlated (r=0.70) in males (Figure 6) and in females (r= 0.25) (Figure 7). The gonad weights increased with increased total length measurements in *L. falcipinnis* in Badagry creek.

Conclusion

The success of sickle fin mullet, *L. falcipinnis* in Badagry creek lies on its reproductive strategy and its diverse forms of foods and feeding habits. The female matured before males, and the sex ratio that favoured females is indicative of availability of more females to fewer males during the spawning season making the fish to be available all the year round. Its occurrence both at wet and dry period showed the species is an euryhaline fish.

The diet composition of this fish in Badagry creek showed a great diversity in its feeding habits. Its feeds on available food organisms at its disposal, ranging from microscopic algae such as diatom (*Coscinodiscus*) to large food item such fish fry. The species has a rare advantage of been able to use all the available resources as food. The fish is described in this study as a detritus and benthic feeder, a carnivore, an herbivore, and a piscivore,

The morphometric measurements, growth patterns, diet composition, and aspects of reproductive biology of *L. falcipinnis* were therefore investigated for the purpose of providing baseline data for carrying out further ecological study on the species, and towards the management and conservation of the fisheries resources of this water body and adjacent lagoon system.

Characterizations of this fish at molecular level of analyses and its population dynamics in Badagry creek are currently attracting our attentions.

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