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FOOD AND FORAGING PERFORMANCE OF *LISA FALCIPINNIS* (VALENCIENNES, 1836) (MUGILIDAE) FROM IMO RIVER ESTUARY, NIGERIA

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ABSTRACT: Food and feeding activities of *Lisa falcipinnis* from Imo river estuary, Nigeria, were studied for 12 months (April 2009 to March 2010). Total length, standard length and body weight were measured. Gut contents were also analysed to identify the food items. Total length of the specimens varied between 9.0 and 21.2cm. The food composition contained 49 items grouped into phytoplankton, detritus, sand and zooplankton, in order of their increasing importance. Females consumed more phytoplankton and detritus than males while males consumed more sand than females. Medium-sized specimens consumed more phytoplankton, detritus and sand than the juveniles and adults. Food items were available throughout the year. *L. falcipinnis* from Imo river estuary fed consistently on some phytoplankton, detritus and bottom sediments of fine particles, as such, are considered selectively polyphagous and mircophagous.

INTRODUCTION

Liza falcipinnis is an important protein source particularly to the low income earners and peasant communities in the coastal regions of Niger Delta, Nigeria. It makes a significant proportion of canoe landing of artisanal fishermen in this region (King, 1988). Studies of this fish specimen include observations in Black Johnson estuary in Sierra Leone (Payne, 1976 and Wilson, 1977). Earlier reports in Nigeria include the work of Fagade and Olaniyan (1973) in Lagos Lagoon, Olaniyan (1984) in Membe waterside , King (1984, 1988) in Bonny river, Akpan and Ubak (2004) in Qua Iboe river estuary and Cross river estuary (Akpan, 2010 a). Meanwhile Imo river estuary is known to have been seriously disturbed by anthropogenic activities particularly from Exxon Mobil and ALSCON companies operating in this area. However, there has been no report on the feeding activities of this fish from Imo river estuary in recent times. This therefore became a prelude to the present study. It is also suggested that the result obtained in this study will be compared with the observation of allopatric species.

STUDY AREA

The study was carried out in Imo river estuary. The area lies in Ikot Abasi Local Government Area of Akwa Ibom State, Nigeria. (Fig.1). It opens into the Atlantic ocean and experiences daily tide fluctuations. This estuarine community is locally called Uta Ewa. Detailed description of this study area has been reported by Udo, (1994).

MATERIALS AND METHODS

The fish specimens were bought at Uta Ewa beach from fishermen monthly between April 2009 and March 2010. The fishes were caught from the Imo river estuary and brought to the beach for sale. The specimens were taken to the laboratory and measurement of Total Length (TL) and Standard Length (SL) were taken.

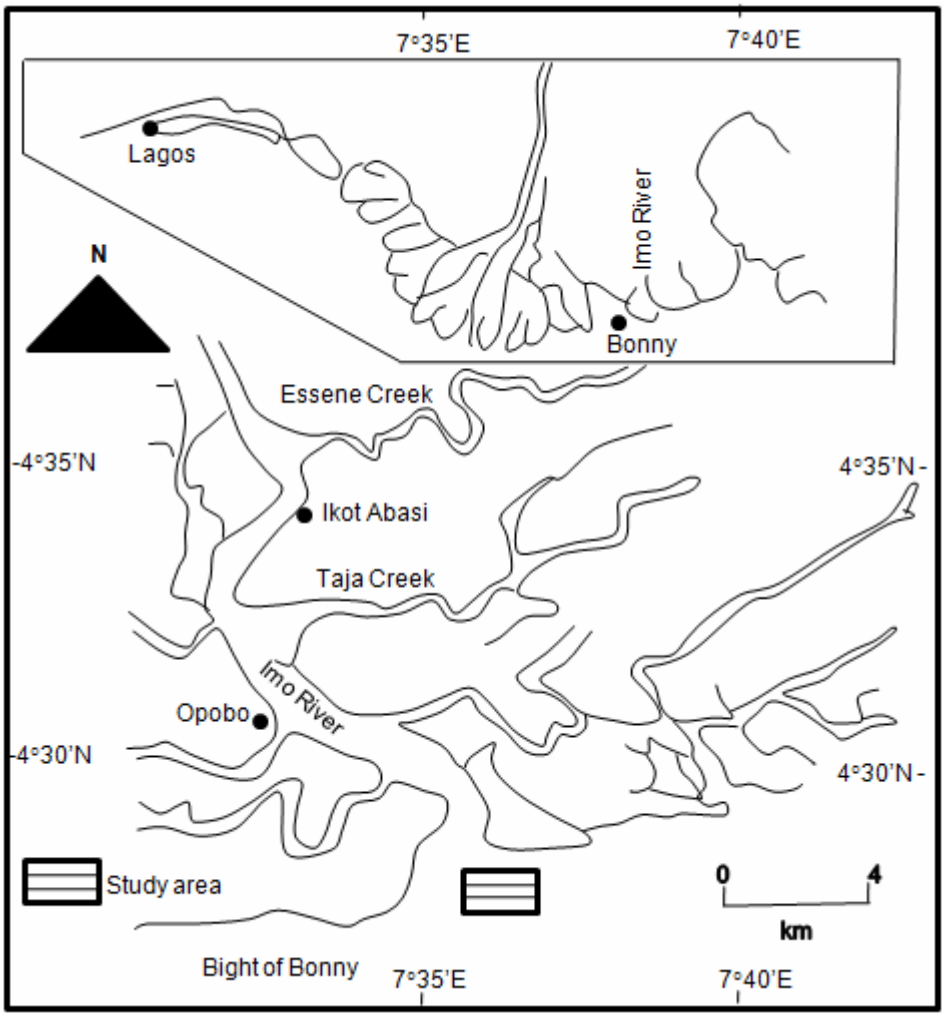

Fig. 1: Imo River Estuary showing the sampling site.

Each specimen was dissected. Stomachs of dissected specimens were removed, opened and stomach fullness (SF) was determined on a 0 – 20 point scale, by observation. Hence 5, 10, 15 and 20 points were allotted to: empty, 25% full, 50% full, 75% full and 100% full stomachs respectively. Stomach repletion index (SRI) and mean stomach fullness (MSF) were used to evaluate feeding activity.

$$SRI = \frac{N_1}{\sum N} \times 100 \qquad 1$$

where N_1 = number of stomachs containing food and $\sum N$ = the total number of specimens examined.

$$MSF = \frac{\sum Ni}{N} \qquad 2$$

where $\sum Ni$ = the sum of frequencies of the stomach points and N is the number of stomachs examined.

The contents of each stomach was placed on a clean slide, teased with few drops of water added to it and examined macroscopically and microscopically at x 10 and x 100 magnifications. The relative frequency and relative dominance of the food items were estimated as an index of food preponderance (IFP):

$$IFP = \frac{RF_1 + RD}{\sum RF + \sum RD} \times \frac{100}{1} \qquad 3$$

where RF_i and RD_i represent relative frequency and relative dominance of each item, while $\sum RF$ and $\sum RD$ are the total relative frequencies and dominance of the dietaries respectively.

This index has a range of 0 – 100%. Items with IFP ≥ 10.0% were considered primary dietaries, those with IFP between 1.0 and 9.9% as secondary. Others with IFP ≤ 1.0% were incidental. Unadjusted food richness (UFR) was considered as the total number of items recorded in the diet (King, 1988). The fishes were divided into three sized –groups; small-sized group (SSG) otherwise the juveniles (9.0- 12.4cm.TL), medium-sized group (MSG) (12.5 – 17. 4cmTL) and large-sized (≥ 17.5cmTL). In grouping 15 cmTL was the median TL and $\pm$ 2 around this median formed the medium-sized group. The grouping was necessary for assessing ontogenetic variation in feeding activities.

Determination of differences in diet composition was assessed by the percentage similarity coefficient(S) (Moss and Eaton 1966):

$$S = \sum_{n-i}^{n} \min (x_1 y_1) \qquad 4$$

where x and y are proportions of the components of the series of items comprising the diets of x and y. This index ranges from zero, for totally dissimilar items to 100% for identical dietaries. How dispersed the items were between various groups was assessed with index of biotal dispersity (IBD) (Koch, 1957) and Diet Breadth (B) (Angermeier, 1982).

$$IBD = \frac{(T - S)}{S(N-1) \times 100} \qquad 5$$

where t = the sum of dietaries in each of n (compared months/seasons), S – the total list of dietaries in n (compared months/ seasons). The index (IBD) ranges from 0 (for completely different set of items) to 100% (for identical set of items in each month/ season)

$$B = [\sum P_1^2)^{-1} - 1]/ n - 1 \qquad 6$$

where P = proportion of the diet compared by resources type i and n = number of food categories in the diet .

Another unified index of diet diversity (F) was computed from the % IFP data using the formula below (Alatalo, 1981, Grundel, 1990), to further confirm the diversity:

$$F = (1/\sum_{i=1}^{n} P_1^2) - 1/\exp (\sum_{i=1}^{n} Pi \ In \ Pi) - 1 \qquad 7$$

where P_1 is the proportion of the diet comprised by resource type i and n = number of food categories in the diet. This index is sensitive to changes in two attributes: food richness and equitability (the degree to which all items are equally represented). It increases as food

richness and equitability increases and declines when few items dominate the diet. The index is scaled such that 1.0 represents an even distribution and zero, a strongly skewed distribution.

RESULT

A total of 399 specimens of *L. falcipinnis* measuring between 9.0 and 21.2cmTL was examined. (Table 1). Specimen ≤ 10.00 cmTL were considered juveniles. Males measured 19.2cmTL and females 21.2cmTL maximum.

Table 1: Monthly samples of *L. falcipinnis* from Imo river estuary , Nigeria

Sex	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Males	07	07	12	21	30	23	20	18	23	16	16	12
Females	12	02	09	29	20	27	21	14	17	11	17	15

Diet composition

Forty nine (49) food items were observed in the diet of *L.falcipinnis* from Imo river estuary (Table 2). The main groups of the food items in order of their importance were phytoplankton (63.38% IFP) detritus (20.56%IFP), sand (14.95%IFP) and zooplankton (1.12% IFP). The overall indices for similarity (F and B) were low (F = 0.487,B = 0.263)

Variation in feeding activities with sex.

Variation in diet with sex (Table 3) depicts 42 dietaries for males and 46 for females. *Tiffany, Ulothrix* and *Undecenchaeta* were absent in the female list while *Anabaenopsi, Gomphasphaena, Egithernia, Chlamydomonas, Spordylomorum. Coscinodiscus* and *Hemiculus* were absent in males' list. Females consumed more phytoplankton, detritus and sand than males, while males consumed more zooplankton (Rotifer) than females. There was no significant difference in the MSF of females and male (MSF = 9.86 $\pm$ 6.21 and 9.25 $\pm$ 6.17 respectively). The stomach repletion index SRI, was slightly higher in females (SRI = 92.35%) than males (SRI = 90.32%) (Table .5). There was no significant difference in the diversity index of females and males (F = 0.715 females, F = 0.722 males). Diet breadth (B) expanded in females (B=0.423) than in males (B = 0.309). Intersexually, Simpson's index was high (S = 89.27).

Ontogenetic foraging activities

Ontogenetic diet plasticity showed more items (45 items) in juveniles followed by the medium size (39 item) and adult (26 item). The juveniles consumed all the dietaries except *Polyathra, Diatom, Gomphasphaena* and *Egithernia.* The medium sized group consumed all items except *Hemiculus, Tiffany, Coscinodiscus, Gomyanlax, Spordylomorum, Chlamydomonas, Helicostomella* and *Undecenchaeta.* The quantity of some of the important dietaries increased from juveniles to medium sizes and decreased at large-sized group (adult) (Table. 4).

The mean stomach fullness increased from juveniles to adults (MSF = 6.89 $\pm$4.76, 10.31 $\pm$ 5.66 and 11.96$\pm$ 8.44). Stomach repletion index also increased from juveniles to medium size and decreased in adults. (SRI = 87.82%, 96.09% and 78.26%). The diversity index of the sized group recorded 59.62. The values of F were high in the three sized groups (F = 0.778, 0.623 and 0.741 respectively. Then diet breadth was low in small-sized group and high in medium-sized group and adult (B = 0.339,0.534 and 0.503 respectively).

Table 2: Diet composition of *Liza falicipinnis* in Imo river estuary, Nigeria.

FOOD ITEMS	**RF**	**RD**	**%IFP**
Phytoplankton:			
Navicula	95	25	7.48
Coelosphaerium	150	27	11.03
Stephanodiscus	24	9	2.06
Pleurosigma	61	16	4.80
Sheletonema	29	6	2.18
Anabaena	75	22	6.04
Pelagobia	5	-	0.31
Polyathra	3	-	0.19
Lauderia	28	2	1.87
Undecenchaeta	2	-	0.12
Strictella	24	17	2.55
Fragillaria	48	11	3.68
Anabaenopsi	1	-	0.06
Oscillatoria	32	7	2.43
Ulothrix	1	-	0.06
Holipedium	2	-	0.12
Spirulina	31	7	2.37
Melosira	3	1	0.25
Helicostomella	2	-	0.12
Diatom	10	1	0.69
Closterium	23	5	1.74
Microstella	9	3	0.75
Gomphasphaena	1	-	0.06
Glosstrichia	10	-	0.62
Microspora	18	3	1.30
Nortoc	11	4	0.93
Nostor	16	3	1.18
Gymnodinium	6	1	0.44
Egithernia	1	-	0.06
Thalassiothrix	7	2	0.56
Asterionella	9	-	0.56
Chlamydomonas	2	-	0.12
Spordylomorum	1	-	0.06
Gomyanlax	4	-	0.25
Planktoniella	10	3	0.81
Quadrigula	7	-	0.44
Aphanocapsa	10	1	0.69
Hyalotheca	4	1	0.31
Hemiculus	1	-	0.06
Euglena	9	2	0.69
Spirogyra	13	3	1.00
Tiffany	1	-	0.06
Coscinodiscus	1	-	0.66
Senedesmus	3	-	0.19
Synedra	26	6	1.99
Subtotal	**829**	**188**	**63.38**
Detritus:			
CPOM	141	17	9.84
FPOM	144	28	10.72
Subtotal	**285**	**45**	**20.56**
Sand	178	61	14.95
Rotifers	179	1	1.12
Food richness			49
Diet breadth	0.267		
F	0.487		

Table 3: Diet Composition Of *Liza falcipinnis* form Imo river estuary, Nigeria Showing Variation With Sex

FOOD ITEMS	**FEMALE**			**MALE**		
	RF	**RD**	**%IFP**	**RF**	**RD**	**%1FP**
Phytoplankton:						
Navicula	44	12	6.71	51	13	8.30
Coelosphaerium	79	18	11.63	71	9	9.66
Stephanodiscus	11	5	1.92	13	4	2.20
Pleurosigma	30	6	4.32	31	10	5.32
Sheletonema	12	2	1.68	17	4	2.72
Anabaena	39	9	5.76	36	13	6.36
Pelagobia	3	-	0.36	2	-	0.26
Polyathra	1	-	0.12	2	-	0.26
Lauderia	18	1	2.28	10	1	1.43
Undecenchaeta	-	2	-	2	-	0.26
Strictella	14	11	2.46	10	6	2.08
Fragillaria	24	8	3.84	24	3	3.50
Anabaenopsi	1	-	0.12	-	-	-
Oscillatoria	16	5	2.52	16	2	2.33
Ulothrix	-	-	-	1	-	0.13
Holipedium	1	-	0.12	1	-	0.13
Spirulina	17	3	2.39	14	4	2.33
Melosira	2	-	0.24	1	1	0.26
Helicostomella	1	-	0.12	1	-	0.13
Diatom	5	-	0.60	5	1	0.78
Closterium	13	3	1.91	10	2	1.56
Microstella	7	3	1.20	2	-	0.26
Gomphasphaena	1	-	0.12	-	-	-
Glosstrichia	7	-	0.84	3	-	0.39
Microspora	6	2	0.96	12	1	1.69
Nortoc	5	1	0.72	6	3	1.17
Nostor	10	1	1.32	6	2	1.04
Gymnodinium	5	1	0.72	1	-	0.13
Egithernia	1	-	0.12	-	-	
Thalassioth	4	2	0.72	3	-	0.39
Asterionella	5	-	0.60	4	-	0.52
Chlamydomonas	2	-	0.24	-	-	-
Spordylomorum	1	-	0.12	-	-	-
Gomyanlax	2	-	0.24	2	-	0.26
Planktoniella	3	2	0.60	7	1	1.04
Quadrigula	5	-	0.60	2	-	0.26
Aphanocapsa	6	1	0.84	4	-	0.52
Hyalotheca	3	1	0.48	1		0.13
Hemiculus	1	-	0.12	-	-	
Euglena	5	1	0.72	4	1	0.65
Spirogyra	9	-	1.08	4	3	0.91
Tiffany	-	-		1	-	0.13
Coscinodiscus	1	-	0.12	-	-	-
Senedesmus	1	-	0.12	2	-	0.26
Synedra	16	4	2.39	10	2	1.56
Subtotal	**432**	**104**	**64.09**	**394**	**86**	**61.83**
Detritus:						
CPOM	74	9	9.95	67	8	9.73
FPOM	66	18	10.07	78	10	10.41
Subtotal	**140**	**27**	**20.02**	**145**	**18**	**20.14**
Sand	90	31	14.51	89	30	15.43
Rotifers	7	-	0.84	10	1	1.43
Food richness			46			42
Simpson's Index(s)		**S = 89.27**				

Table 4: Ontogenetic variation in the diet composition of *Liza falcipinnis* in Qua Iboe river estuary, Nigeria.

Food Items	9 – 12.4			12.5 – 17.4			17.5 - 24		
	RF	RD	%IFP	RF	RD	%IFP	RF	RD	%IFP
Phytoplankton:									
Navicula	36	8	7.51	54	16	7.60	5	1	6.82
Coelosphaerium	46	9	9.39	92	16	11.73	7	2	10.23
Stephanodiscus	10	2	3.41	19	8	2.93	2	-	2.27
Pleurosigma	19	4	3.92	35	14	5.32	2	-	2.27
Sheletonema	14	5	3.24	14	1	1.63	-	-	-
Anabaena	41	9	6.53	12	13	14.55	3	2	5.68
Pelagobia	4	-	0.68	1	-	0.11	-	-	-
Polyathra	-	-	-	1	-	0.11	1	-	1.14
Lauderia	16	2	3.07	11	1	1.30	-	-	-
Undecenchaeta	2	-	0.34	-	-	-	-	-	-
Strictella	5	2	1.19	15	12	2.93	5	3	9.09
Fragillaria	23	5	3.74	20	6	2.82	-	-	-
Anabaenopsi	1	1	0.34	-	-	-	-	-	-
Oscillatoria	15	-	2.56	11	4	1.63	3	5	9.09
Ulothrix	1	-	0.17	-	-	-	-	-	-
Holipedium	2	-	0.34	-	-	-	-	-	-
Spirulina	9	2	1.88	16	5	2.28	2	1	3.41
Melosira	2	1	0.51	1	-	0.11	0	-	-
Helicostomella	2	-	0.34	-	-	-	-	-	-
Diatom	-	-	-	9	1	1.09	1	-	1.14
Closterium	13	2	1.56	9	3	1.31	-	-	-
Microstella	4	2	1.02	5	1	0.65	-	-	-
Gomphasphaena	2	-	0.34	6	-	0.65	1	-	1.14
Glosstrichia	-	-	-	1	-	0.11	-	-	-
Microspora	5	-	0.85	13	1	1.52	-	1	1.14
Nortoc	9	1	1.71	6	1	0.76	1	1	2.27
Nostor	7	-	1.19	9	3	1.31	-	-	-
Gymnodinium	1	-	0.17	4	-	0.43	2	-	2.27
Egithernia	-	-	-	1	-	0.11	2	1	3.41
Thalassiothrix	2	2	0.68	4	-	0.43	-	-	-
Asterionella	4	-	0.68	5	-	0.54	-	-	-
Chlamydomonas	2	-	0.34	-	-	-	-	-	-
Spordylomorum	1	-	0.17	-	-	-	-	-	3.41
Gomyanlax	4	-	0.68	-	-	-	-	-	1.14
Planktoniella	5	2	1.19	3	1	0.43	-	-	-
Quadrigula	4	-	0.68	3	-	0.33	-	-	1.14
Aphanocapsa	1	-	0.17	4	-	0.43	2	1	-
Hyalotheca	2	-	0.34	1	1	0.22	1	-	-
Hemiculus	4	-	0.68	-	-	-	-	-	-
Euglena	1	-	0.17	8	1	1.09	-	1	-
Spirogyra	4	1	0.85	9	2	1.19	-	-	1.14
Tiffany	1	-	0.17	-	-	-	-	-	68.2
Coscinodiscus	1	-	0.17	-	-	-	-	-	6.82
Senedesmus	2	-	0.34	1	-	0.11	-	-	5.68
Synedra	5	1	1.02	15	5	2.17	1	-	12.5
Subtotal	**332**	**61**	**64.33**	**417**	**117**	**69.93**	**41**	**19**	**19.30**
Detritus:									
CPOM	56	6	10.58	60	20	8.69	6	-	-
FPOM	44	7	8.70	53	20	7.93	5	-	-
Subtotal	**100**	**13**	**19.28**	**113**	**40**	**16.62**	**11**	**-**	**-**
Sand	55	17	12.29	96	28	13.46	11	5	19.30
Rotifers	7	1	1.37	10	-	1.09	-	-	-
Food richness			45			38			24
Simpson Index				S = 59.62					

Table 5: Variation in stomach fullness and stomach repletion index with sexes and sizes of *Lisa falcipinnis* from Imo river estuary, Nigeria.

	Stomach fullness							
Groups	**0**	**5**	**10**	**15**	**20**	**N**	**MSF**	**SRI**
Males	18	76	35	30	27	86	9.25±6.17	90.32
Females	14	66	49	19	35	183	9.86±6.21	92.35
Juveniles	19	85	33	12	7	156	6.89±4.76	87.82
Medium sizes	7	62	49	35	26	176	10.31±5.66	96.09
Large sizes	5	4	2	1	11	23	11.96±8.44	78.26

Monthly variations in feeding activities

The main groups of food items occurred in all the months except zooplankton which occurred only in 5 months (April to August) (Table 6). Monthly food richness varied between 7 in January and 39 in April. Seven plankton had above 50% annual spread. The monthly mean stomach fullness and stomach repletion index were high.

DISCUSSION

Diet composition

L. falcipinnis from Imo river estuary varies in total length between 9.0cm and 21.2cm. Its diet consisted of four important groups of dietaries in order of importance viz: phytoplankton (63.38 % IFP), detritus (20.56%FP), sand (14.95%IFP) and zooplankton (1.12%IFP). Detritus were derived primarily from the decaying shed leaves of mangrove (*Rhizophora)* macrophyte (King, 1984). Phytoplankton, detritus and sand are the primary dietaries while zooplankton are secondary items. The occurrence of fine sand particles and mud in all the stomachs observed suggests the fish to be a deposit feeder as reported by workers in other water bodies. It also suggests that the phytoplankton observed are epibenthic. The fish subsists on grazing and detrital chains. Usually deposit / bottom feeders are non selective, as such, the gut content should have contained many other items. In contrast, the items observed were consistent, making the fish trophoselective. The large number of phytoplankton observed enables the fish to obtain much of its nutrients from these microflora. The specimens from Imo river estuary are more microflora euryphagous than their allopatric species from Cross river estuary (Akpan, 2010a,c). The difference in number of phytoplankton may depend on the availability of the phytoplankton in the waterbody and variations in tidal flow. *Coelosphaerium* and *Navicula* were more than others as indicated by their food preponderance indices (11.03%IFP and 7.48%IFP respectively).

The ingestion of sediments (fine sand /mud) is a normal behaviour of this fish (Akpan and Ubak 2004, Akpan, 2010a). The sediment supplies silicates (King *et al*, 1990), amino acids and organic products of decayed bacteria and protozoan (Welcomme 1979). The fine sand assist in fine breaking/ crushing of phytoplankton (Akpan 2010a). This function is important as the phytoplankton have cell walls that need to be mechanically broken for efficient digestion. The zooplankton was not much and could had been inadvertently ingested with other items.

The overall diet diversity index (F = 0.487) indicates that the food items were diverse and evenly distributed. The general stomach depletion index was high too (SRI = 90.32%) with 92.35% of the specimens observed having full stomachs. This indicates that the fish is an active feeders, a habit probably enhanced by food abundance in the estuary.

Table 6: Monthly Food Composition Of *Liza falcipinnis* In Imo River Estuary, Nigeria

FOOD ITEMS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AGU	SEP	OCT	NOV	DEC
Phytoplankton:												
Navicula		10.94	4.67	5.53	7.22	7.73	10.09	5.55	10.34	18.14	8.84	3.81
Coelosphaerium	8.17	7.81	5.33	15.57	9.48	6.41	10.69	7.14	13.79	9.45	11.58	12.38
Stephanodiscus	-	-	3.33	0.69	1.72	3.85	5.24	3.97	-	1.57	2.72	8.57
Pleurosigma	6.25	9.38	3.33	7.95	4.81	4.81		5.55	2.75	9.45	3.40	-
Sheletonema	-	-	3.33	2.77	2.75	3.85	2.42	5.55	-	-	-	-
Anabaena	4.17	9.38	7.33	8.99	7.90	4.81	8.27	3.97	4.83	1.57	-	7.62
Pelagobia	-	-	-	0.35	0.34	-	-	-	-	-	-	-
Polyathra	-	-	-	-	-	-	-	-	-	-	1.36	-
Lauderia	-	-	6.00	1.73	4.47	4.33	-	2.38	-	-	-	-
Undecenchaeta	--	-	-	0.69	-	-	-	-	-	-	-	-
Strictella	2.08	-	-	0.35	-	-	8.87	3.99	-	-	10.88	6.67
Fragillaria	-	4.69	3.33	7.27	8.25	4.33	-	3.97	-	-	-	-
Anabaenopsi	-	-	-	0.69	-	-	-	-	-	-	-	-
Oscillatoria	6.25	-	2.00	0.69	1.03	4.33	5.24	4.76	-	3.15	-	3.81
Palagobra	-	-	-	-	-	1.44	-	-	-	-	-	-
Ulothrix	-	-	-	0.35	-	-	-	-	-	-	-	-
Holipedium	-	-	-	0.69	-	-	-	-	-	-	-	-
Spirulina	-	3.13	2.67	2.08	4.12	3.36	7.06	4.76	-	-	-	-
Melosira	-	-	4.67	-	1.92	-	-	-	-	-	-	-
Tilubraia	-	-	-	0.35	-	-	-	-	-	-	-	-
Diatom	-	-	-	-	-	-	-	-	-	-	4.76	-
Helicostomella	-	-	-	0.69	-	-	-	-	-	-	-	-
Closterium	-	3.13	4.67	1.38	3.44	3.36	-	4.76	-	-	-	-
Microstella	-	-	2.00	1.04	0.34	1.44	-	3.97	-	-	-	-
Glosstrichia	-	-	-	-	-	-	-	-	-	-	4.08	3.81
Gomphashaena	-	-	-	0.35	-	-	-	-	-	-	-	-
Microspora	12.66	-	-	-	-	0.48	-	-	2.75	3.15	-	3.81
Nortor	-	-	-	0.35	1.38	1.92	1.80	1.58	-	-	-	-
Nostor	-	-	2.00	1.38	1.72	0.48	-	-	4.14	0.79	-	-
Amphora	-	-	-		0.69	0.48	-	-	-	-	-	-
Gymnodinium	-	7.81	-	1.04			2.42	-	-	-	-	-
Thalassiothrix	-	-	-	1.04	0.34	1.44	-	0.79	-	-	-	-

Table 6: (continued)

FOOD ITEMS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AGU**	**SEP**	**OCT**	**NOV**	**DEC**
Phytoplankton:								-	-	-	-	-
Asterionella	-	-	3.33	0.35	0.69	2.55	-	-	-	0.78	-	-
Chlamydomonas	-	6.25	4.67	0.35	-	0.48	-	-	-	-	-	-
Spirogyra	-	-	-	-	-	-	-	-	-	6.29	5.44	3.81
Egitheria	-	-	-	0.35	-	-	-	-	-	-	-	-
Spordylomorum	-	-	-	0.35	-	-	-	-	-	-	-	-
Euglena	-	3.13	-	-	-	-	-	-	2.75	1.57	2.72	-
Gonyanlax	-	-	-	0.35	-	1.44	-	-	-	-	-	-
Planktoniella	-	-	-	0.69	1.38	2.40	-	-	-	4.72	-	-
Pediastum	-	-	-	-	1.38	-	-	-	-	-	-	-
Quadrigula	-	-	2.67	1.04	0.69	0.96	-	-	-	-	-	-
Coscinodicus	-	-	-	0.35	0.69	-	-	-	-	-	-	-
Senedesmus	-	-	-	0.35	0.69	-	-	-	-	-	-	-
Synedra	16.67	1.56	5.33	-	0.34	0.96	2.42	3.97	-	2.36	5.44	-
Tiffany	-	-	-	0.35	-	-	-	-	-	-	-	-
SUB TOTAL	**56.25**	**67.21**	**70.66**	**68.52**	**67.70**	**68.64**	**63.70**	**66.66**	**41.35**	**55.92**	**61.22**	**54.31**
Detritus:												
CPOM	10.42	7.81	6.67	11.76	9.97	8.21	8.27	7.14	11.03	11.81	9.52	11.43
FPOM	10.42	7.81	6.00	10.72	10.99	8.21	10.69	7.14	13.79	8.66	12.25	14.26
SUBTOTAL	**20.84**	**15.62**	**12.67**	**22.48**	**20.96**	**16.42**	**18.96**	**14.28**	**24.82**	**20.47**	**21.77**	**25.69**
Sand	22.19	17.19	11.34	8.65	10.31	10.61	15.54	16.68	33.83	23.61	17.01	20.00
Rotifers	-	-	5.33	0.35	1.03	4.33	1.80	2.38	-	-	-	-
Food richness	10	14	22	39	29	28	15	20	10	16	14	12
SRI	57.59	100.00	100.00	96.00	100.00	94.00	92.68	90.63	90.00	88.88	87.88	92.59
MSF	2.89± 2.47	14.44± 3.69	14.52± 4.61	8.40± 4.6	10.6± 5.59	8.80± 5.11	12.44± 6.53	11.72± 6.30	5.00± 5.00	10.37± 6.52	16.36± 6.88	6.48± 2.99

Intersexual foraging activity

Both sexes fed on the same food resource base. Females consumed more phytoplankton (64.09% IFP) and detritus (24.58%IFP) than males (60.96% IFP and 20.14% IFP respectively). Males on the other hand, consumed more sand (15.43% IFP) than females (14.51%IFP). The difference in item selectivity could be due to demands for ovarian development. The values for diversity in diet composition of males and females where high (F = 0.722 males and 0.715 females). Other similarity indices were also high (S = 59.62%, IBD = 79.59). These indices mean that the items were widely dispersed within each sex group and greatly similar between sexes. The slightly high SRI of females (SRI =92.35%) than males (SRI = 90.32%) suggests higher feeding activities in females than males. Furthermore, the diet breadth of females expanded (B=0.423) more than in males (B=0.309). According to the optimal foraging theory (Schoener, 1971, Pyke *et al*, 1977, Angermeier 1982) contraction of diet breadth indicates periods of resource abundance. It is implicit that females had fewer dietaries than males suggesting diet shift for coexistence.

Ontogenetic feeding activity

The ontogenetic diet composition showed the same food items in the three age groups. The different sized groups consumed more phytoplankton than the other dietaries (Table 5). This was followed by detritus and sand in juveniles and medium sizes. The quality of each group of items consumed by the age groups increase from juveniles to medium – sizes and then decreases in adult size. Stomach depletion index also increases from juveniles to medium size and decreases in adult (SRI = 87.82%, 96.09% and 78.26% respectively). This indicates that feeding increases from juveniles to a peak in the middle size-group and declines at the adult age. A similar observation had been reported by Akpan (2010c) on *L. falcipinnis* from Cross river estuary. Although foraging activities increase with fish size, at adult stages feeding is depressed due to age effects.

The mean stomach fullness was high in all the stages and it increased from juveniles to adult. (MSF = 6.89$\pm$4.76, 10.31 $\pm$5.66 and 11.96$\pm$8.44 respectively). Indices of dietary diversity showed similarities in the food items of the different age groups. (S = 59.62%, IBD = 58.16), (F = 0.778, 0.623 and 0.641 respectively). The diet breadth was small in juveniles (B = 0.339) but higher in the medium size (B = 0.534) and adults (B = 0.503) depicting food resource abundance at juvenile stage. This suggest micro trophic niches between the age cohorts which enhance coexistence.

Monthly foraging activities :

The important groups of food items were observed in all the months (Table 7). The distribution of different planktons differed greatly. Thirteen planktons (*Navicula*, *Coelosphaerium, Stephanodiscus, Pleurosigma, Sheletonema, Anabaena, Strictella, Fragillaria, Oscillatoria, Spirulina, Closterium, Nostor and Synedra)* had annual spread of ≥ 50%. Of these, *Coelosphaerium* occurred in all the months while *Navicula* and *Anabaena* occurred in 11 months. Sand and detritus occurred in all the months (Fig. 2) while rotifers were observed in 6 months. The mean stomach fullness varied between 2.89$\pm$2.47 and 16.36$\pm$6.88 with the highest record in November. Stomach repletion index was high between 57.57% in January and 100% in February, March and May. Index of biotal diversity was comparatively low (IBD = 31.90). These show that feeding activity was high throughout the year but higher in some months than others. Diet breadth varied with the months and was low in April (B-0.288). The highest value was observed in March (B=0.864) (Table 7). Comparatively low values indicate periods with increased resource abundance. Despite this, the F index was generally high (Table 7) indicating equity in the distribution of dietaries throughout the year.

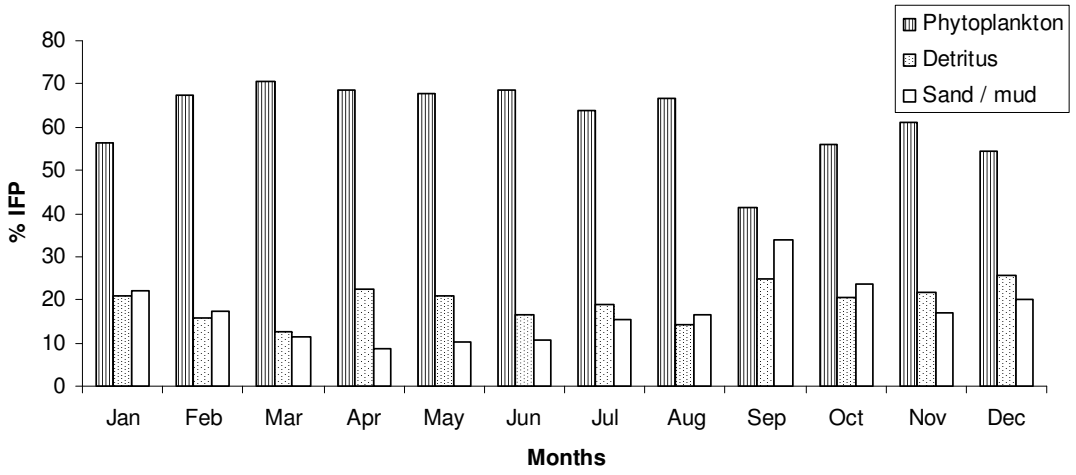

Fig. 2: Monthly distribution of important diet groups of *Liza falcipinnis* from Imo River estuary, Nigeria.

Table 7: Monthly variations in diet breadth (B) and F index of *Liza falcipinnis* from Imo river estuary, Nigeria

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
B	0.850	0.850	0.864	0.288	0.511	0.685	0.775	0.751	0.612	0.485	0.779	0.799
F	0.862	0.813	0.927	0.669	0.781	0.906	0.845	0.527	0.734	0.588	0.864	0.853

Liza falcipinnis in Imo river estuary subsists primarily on phytoplankton, detritus and sediments all of which are microscopic. Considering earlier reports on its feeding habit as deposit feeder, inter-alia, it should also be noted that this fish is microphagous. It therefore has a multidimensional feeding attribute. Moreover, the high trophic performance demonstrated by *L. falcipinnis* in this study is an indication of its high adaptability to the ecomechanical / ecophysiological alteration of this ecosystem.

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