International Journal of Fisheries and Aquatic Studies 2015; 3(2): 346-352

ISSN: 2347-5129
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.352
IJFAS 2015; 3(2): 346-352

www.fisheriesjournal.com
Received: 16-09-2015
Accepted: 18-10-2015

Imaobong E Ekpo
Department of Fisheries & Aquatic Environmental Management, University of Uyo, P. M. B 1017, 520001, Akwa Ibom State – Nigeria.

Mandu A Essien-Ibok
Department of Fisheries & Aquatic Environmental Management, University of Uyo, P. M. B 1017, 520001, Akwa Ibom State – Nigeria.

Ezekiel E Effiong
Department of Fisheries & Aquatic Environmental Management, University of Uyo, P. M. B 1017, 520001, Akwa Ibom State – Nigeria.

Correspondence
Imaobong E Ekpo
Department of Fisheries & Aquatic Environmental Management, University of Uyo, P. M. B 1017, 520001, Akwa Ibom State – Nigeria.

Biology of bigmouth sleeper, *Eleotris vittata* (Dumèril, 1861) (Pisces: Eleotridae) in the lower Cross River, Nigeria

Imaobong E Ekpo, Mandu A Essien-Ibok, Ezekiel E Effiong

Abstract
Between May and December 2014, the abundance, condition factor, length-weight relationship, food and feeding habits of the bigmouth sleeper, *Eleotris vittata* were studied in the lower Cross River, Nigeria. Data generated were subjected to statistical analyses analysis at 0.05 probability level. A total of 231 specimens were collected and examined. The highest number was recorded in the month of December (79 specimens; 34.20%) while September (2 specimens; 0.87%) had the least. The highest monthly condition factor was recorded in June (1.56) while November (1.30) had the lowest. *E. vittata* had total length and total weight ranges of 8.10-110.30cm and 5.07-342.70g respectively. Seasonal variation in abundance of *E. vittata* was higher (121 specimens; 52.38%) during the wet season than the dry season (110 specimens; 47.62%). The results obtained from the length-weight relationship graph showed that the growth pattern of the fish was negatively allometric with b values of 0.16 obtained at $P<0.05$. There was moderate correlation between the length and weight of the specimens as the correlation coefficient (r) was 0.5586. Feeding intensity was highest in the month of June (88.89 %GRI) and lowest in September (50.00 % GRI). The gut contents revealed that 5 food items were ingested of which three were of primary importance (crustaceans 78.83 %IFD, Pisces 18.88 %IFD and molluscs 10.32 %IFD) while the rest of the items (nematode 4.42 %IFD and macrophytes 3.51 %IFD) were of secondary importance. Hence, *E. vittata* is an invertivore-piscivore.

Keywords: *Eleotris vittata*, feeding habits, size variation, condition factor, lower Cross River

1. Introduction

The family Eleotridae (Perciformes) comprises about 35 genera and 155 species which inhabit tropical and subtropical areas worldwide. [1, 2] reported the family Eleotridae as being among the world's most widely distributed fish. They occurred throughout most of the West African coastline and can be found worldwide in tropical and subtropical regions, but are rarely found in temperate areas [3, 4]. In the Nigerian coastal waters, Eleotrid species comprise *Bostrychus africanus, Dormitator lebretonus, Eleotris vittata* and *Eleotris danganensis* [5] and they are found in both fresh and brackish waters [6, 7] classified *E. vittata* as a creeklet-dominated species while working in the intertidal fish communities of the Cross River estuary.

Data of the functional Length-Weight Relationship (LWR) is important for fish stock assessment [8], estimation of growth rates and age structure [9], calculation of the standing stock biomass [10], condition indices [11, 12] and several other aspects of fish population dynamics [13, 14]. Like any other morphometric characters, the LWR can be used as a character for the differentiation taxonomic units and the relationship changes with the various development events in life such as metamorphosis, growth and onset of maturity [15].

Condition factor, K is an index of the degree of fatness or well-being of a species [16]. The study of condition factor is important to understand the life cycle of fish species, contribute to an adequate management of the species and to maintain the ecosystem equilibrium [17]. This factor is calculated from the relationship between the weight of a fish and its length, with the intention of describing the "condition" of that individual fish [18]. Different values in K of a fish indicate the state of sexual maturity, the degree of food sources availability, age and sex of some species [19].

The study of the food and feeding habits of aquatic species is a subject of continuous research because it constitutes the basis for the development of a successful fisheries management programmed on fish capture and culture [20]. Nature offers a great diversity of organisms that are used as food by fish, and these differ in size and taxonomic groups [21, 22] observed that the dietary analysis of organisms in their natural habitat enhances the understanding of the growth, abundance, productivity and distribution of these organisms. [23] observed that fish abundance in different habitats is associated with availability and abundance of food and substrate types in a particular habitat.

There is paucity of information on the food and feeding habits of *E. vittata* in the lower Cross River. Little attention has been given to some aspects of the ecology of *E. vittata* in the lower Cross River [24]. Thus, this study complements and expands such literatures, but will further provide useful information to fisheries scientists who require these data to make informed research decisions.

2. Materials and methods

2.1 Study Area

The present study was conducted in the lower Cross River at Ayadehe in Itu Local Government Area, Akwa Ibom State, Nigeria. It lies between latitude 5^0 10′N and longitude 8^0 3′E. The area is bounded in the north by Cross River State, west by Ibiono Ibom Local Government Area, east by Uruan Local Government Area, and south by Uyo Local Government Area (Fig. 1). The river rises from the Cameroon mountains and flows south-westwards into the Atlantic Ocean. The lower Cross River lies within a typical tropical humid climate, which is characterized by distinct dry and wet seasons, with peak dry season occurring in December – February [25, 26]. The dry season which lasts from November - March is influenced by the hot north-eastern continental air mass from the Sahara Desert and is characterized by fairly high temperature. Relative humidity is usually high throughout the year. Maximum rainfall occurs during the months of June - September [27]. Its dominant vegetation include trees (*Elaeis guineensis*), Bamboo (*Bambusa africana*), plantain and banana (*Musa spp*), and guinea grass (*Pannicum maximum*). This station is characterized by a sandy erosion and muddy bankroot biotopes made up of silt. The common activities across the entire stretch of the river are fishing and agricultural crop farming on the floodplains especially during the dry season.

2.2 Fish sampling

Samples of *Eleotris vittata* which were the only species of the eleotrid family found in the station (Itu) were collected bi-monthly and randomly for a period of 8 months (May - December 2014) from selected artisanal fishers. The fishing gears used comprised of mainly basket traps and cast nets (with mesh size of 1-25mm) [28].

2.3 Preservation

Fish samples were preserved in 10% formaldehyde solution in well-labelled containers to reduce microbial digestion to the minimum [29, 30]. All preserved samples were removed from the formaldehyde solution, rinsed in clean water and placed slanting with the mouth down to drain out excess fluid for about 5-10 minutes prior to identification and laboratory analysis.

2.4 Measurement and identification

The total length was measured to the nearest 0.1cm using a standard measuring board (1-50cm) as described by [31]. The weight was taken with an electronic weighing balance TDA Series Precision Balance with Model No. TDA: 6002A to the nearest 0.1g. The specimens were dissected and their guts carefully removed. *E. vittata* had no defined stomach, thus, the intestine was used as the gut [32]. Furthermore, the food items in the guts were stored after being carefully removed by the use of forceps in 4% formalin until the contents were analyzed [33].

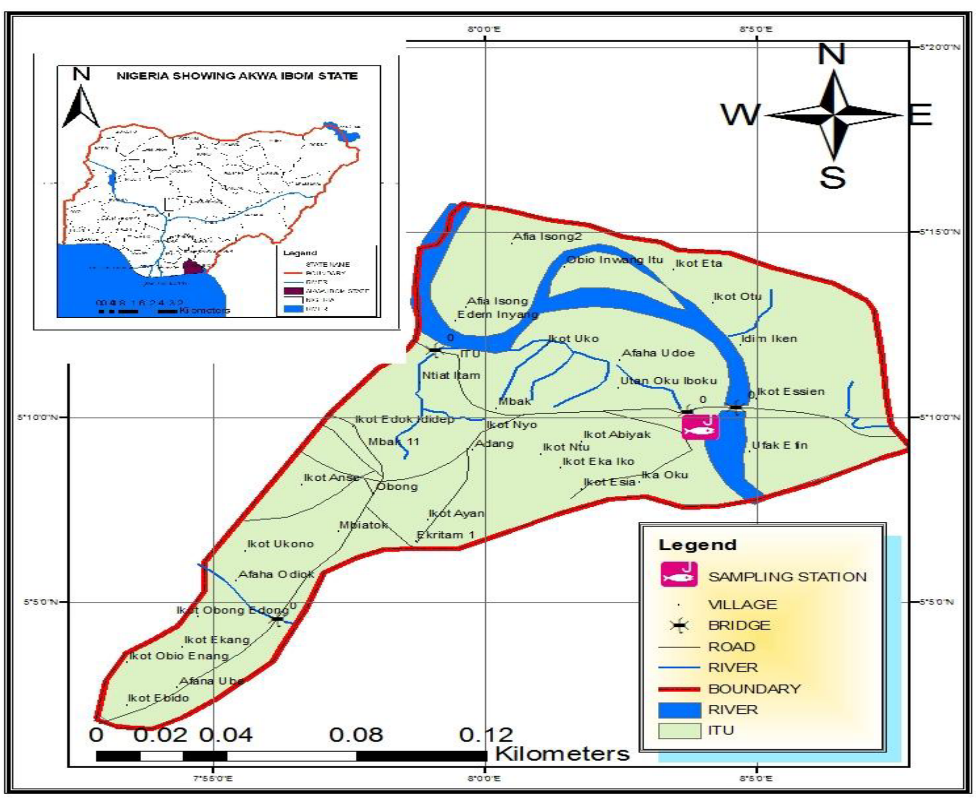

Fig 1: Map of Itu L. G. A. showing the sampling station at Ayadehe in the lower Cross River, Nigeria (Insert: Map of Nigeria showing the location of Akwa Ibom State).

2.5 Statistical analysis
SPSS (version 19) package was used to determine the means, range, one way ANOVA and Duncan Multiple Range Tests. Microsoft Excel 2010 was used for graphical illustrations of all parameters.

2.6 Length-Weight Relationship (LWR)
The relationship between the length and weight of the fish were established using the parabolic equation [18]:

$$W = aL^b \text{ -- [1]}$$

Where W = Weight of fish (g); L= Length of fish (cm); a = Constant and b = an exponential expressing the relationship between length-weight.
The relationship when converted into the logarithmic form gives a straight line relationship graphically thus:

$$\text{Log } w = \text{Log } a + b \text{ Log } L \text{ --------------------------------------- [2]}$$

Where b = slope of the line; a = constant
Relative abundance was estimated from the index of preponderance (%IP), which takes account of both number and weight [34, 35]:

$$IP = \frac{100(\%N.\%TW}{\Sigma(\%N.\%TW)} \text{ --- [3]}$$

Where
%N = percentage number of the species; and %TW = percentage weight of all the species sampled during the study.

2.7 Condition Factor (K)
Condition factor (K) which is the degree of fatness or corpulence or well-being of a specimen was calculated using [36]:

$$K = \frac{100W}{L^3} \text{ --- [4]}$$

Where
W = Weight (g); and L = Length (cm)
100 is a factor to bring the value of K near unity.

2.8 Stomach content analysis
There are several indices for expressing the quantitative importance of different food items in the diets of fish as described by [37-39]:

2.8.1 Point method (P):
The total point (TP) per food item (based on the point's volume of the gut fullness) was shared among the gut contents in units proportional to their visually estimated bulk. Each gut was awarded points based on the nature of fullness of the gut (in this case, the intestine). The degree of fullness of each gut was estimated by an arbitrary 0-20 points scale; such that 0, 5, 10, 15 and 20 points were allotted to empty, ¼ full, ½ full, ¾ full and full guts respectively [40].
The total points (PP) and frequency of occurrence (FO) of each food object were assessed and the index of food (%IFD) estimated. The gut contents of each specimen were later placed on a petri dish and were carefully examined with the unaided eye and a compound microscope. The contents were sorted, identified and the importance of each was assessed by frequency and point methods [39] which were later modified by [41].
Formula for relative importance of food items was given as:

$$Rf = \frac{F_i}{\Sigma F_i} \times 100 \text{ -- [5]}$$

Where: F_i = Frequency of item I; and ΣF_i = Total sum of F_i.
All RF values sum up to 100, thus, the integrated importance of each item was then expressed as an index of food dominance (IFD) by [38] according to the formula:

$$IFD = \frac{RF.PP \times 100}{\Sigma (RF.PP)} \text{ -- [6]}$$

Where: RF = Relative Frequency of food item; PP = Point Percentage

2.8.2 Gut Repletion Index
This reflects the number of non-empty guts divided by the total number of guts and multiplied by 100. It is mathematically expressed as:

$$GRI = \frac{\text{number of non-empty gut of sampled specimens}}{\text{Total number of gut sampled}} \times 100 \text{ ---------- [7]}$$

This index ranges from 0 to 100%. The use of IFD to establish overall food preponderance is adequate as it incorporates the RF and PP data, thus minimizing the bias characteristic of cases in which results from different analytical methods are independently interpreted.

3. Results
3.1 Monthly abundance and size range
A total of 231 specimens of *E. vittata* were examined as the only Eleotridae in the lower Cross River. There were statistical differences among the months at 0.05%. The degree of effective contribution (%IP) showed that December (49.38%) had the most significant contribution and was followed by July (19.85%). October and November recorded 12.76% and 10.89% respectively; June and August had (3.34%) while September (0.03%) made the least contribution. The frequency of occurrence (%N) followed the same pattern as %IP with December being the most abundant (79 specimens; 34.20%) while September was the least (2 specimens; 0.87%). Seasonal variation in abundance of *E. vittata* was higher (121 specimens; 52.38%) during the wet season than the dry season (110 specimens; 47.62%). The fish measured 8.10 - 110.30cm TL range and 17.38cm mean TL while they weighed 5.07 - 342.70g TW range and 74.72g mean TW as shown in Table 1.

3.2 Length-Weight Relationship (L-WR)
The values of the regression coefficients (a and b) and correlation coefficient (r) were shown in Fig. 2. The intercept (a) value of the fish was 1.30 and the corresponding exponent b value was 0.16. The exponent b value of the fish was less than 3 and indicated negative allometric growth pattern while the r which had the value of 0.55 showed a degree of weakly positive correlation. There was no significant ($P<0.05$) correlation. The regression graph gave a straight line relationship which implied that as the fish increased in length, their weight also increased.

Table 1: Monthly variation in size and abundance of *E. vittata* in the lower Cross River, Nigeria.

MONTH	N	%N	Ranges		Mean			IP (%)	GRI (%)
			TL (cm)	TW (g)	TL (cm)	TW (g)	K		
MAY	6	2.60	14.5-21.0	37.99-126.59	17.18	74.47	1.34	0.41	66.69
JUN	18	7.79	12.3-24.0	28.06-194.45	15.93	67.68	1.56	3.34	88.89
JUL	48	20.78	10.0-22.0	12.49-163.97	15.85	61.68	1.41	19.85	68.75
AUG	15	6.49	12.4-27.7	24.71-301.12	18.19	97.45	1.46	3.34	86.67
SEPT	2	0.87	14.6-16.0	45.8-57.60	17.87	92.37	1.46	0.03	50.00
OCT	32	13.85	8.80-28.50	8.60-342.70	16.27	71.27	1.48	12.76	56.25
NOV	31	13.42	8.10-110.3	5.07-210.63	20.22	74.41	1.30	10.89	54.84
DEC	79	34.20	9.60-110.0	13.4-161.0	17.53	58.43	1.34	49.38	79.75
TOTAL	**231**	**100**						**100**	

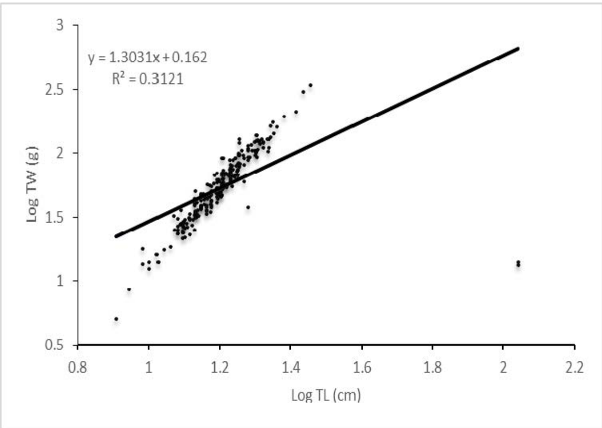

Fig 2: Length-Weight Relationship (LWR) of *Eleotris vittata* in the lower Cross River, Nigeria.

3.3 Condition factor

Monthly variations in condition factor (K) of *Eleotris vittata* revealed that the least body condition (K=1.30) was obtained in November, depicting dry season while the highest (K=1.56) was observed in June depicting wet season. The fish body condition was generally high (mean K-value = 1.42) (Table 1).

3.4 Feeding intensity

Table 1 showed that GRI (%) was highest in June (88.89%) and least in September (50.00%). The other monthly GRI (%) in descending order were: 86.67% (August), 79.75% (December), 68.75% (July), 66.69% (May), 56.25% (October) and 54.84% (November). The result from the monthly feeding intensity of *E. vittata* showed that the index of empty guts decreased from September to June while that of full guts decreased from September to November. Stomach fullness recorded in Table 2 was as follows: 0 (66 guts, 28.57%), 5 (51 guts, 22.08%), 10 (16 guts, 6.92%), 15 (23 guts, 9.96%) and 20 (75 guts, 32.47%). The overall feeding intensity of the fish revealed that out of 231 specimens, 66 guts (28.57%) had empty guts while 165 guts (71.43%) had food in their guts, hence, stomachs with food were higher than those without food.

Table 2: Composite feeding intensity of *Eleotris vittata* based on degree of stomach fullness in the lower Cross River, Nigeria.

Points	N	%
0	66	28.57
5	51	22.08
10	16	6.92
15	23	9.96
20	75	32.47
Total	**231**	**100**

3.5 Diet composition

The trophic spectrum of *E. vittata* was illustrated in Table 3 and Fig. 3. Five major dietary compositions were identified in the fish stomachs. The dominant food item was crustaceans (74.40%) while the lowest was macrophytes (2.63%). Others were Pisces, molluscs and nematodes having IFD of 18.88%, 7.29% and 4.42% respectively. These dietaries comprised of crustaceans (*Callinectes sp* and *Macrobrachium sp*), Pisces (unidentified fish), Mollusca (*Tympanotonus fuscatus* and *Pomecia palludosa*), nematodes and macrophytes (plant roots, seeds and leaves). All the food items were primarily important in the diet of the eleotrids.

Table 3: Overall food composition of *Eleotris vittata* in the lower Cross River, Nigeria.

Food Items	%RF	%PP	%IFD
Crustacea			
Callinectes sp	30.73	33.66	73.83
Macrobrachium sp	25.49	31.08	7.03
Total Crustacea	**65.22**	**64.74**	**80.86**
Macrophytes			
Leaves	1.33	0.44	0.03
Seed	2.40	0.70	0.03
Root	7.84	2.97	0.97
Total macrophytes	**11.57**	**4.11**	**1.03**
Molluscs			
Tympanotonus fuscatus	1.85	2.85	5.7
Pomecia palludosa	9.83	8.30	2.16
Total Molluscs	**11.68**	**11.15**	**7.86**
Nematodes	**8.72**	**2.30**	**3.12**
Pisces			
Unidentified fish	**12.10**	**17.69**	**7.13**

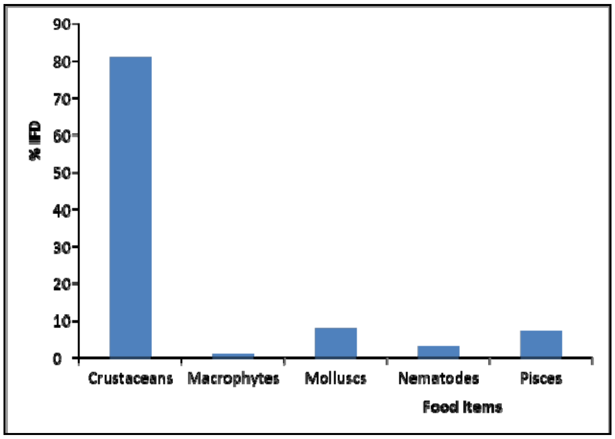

Fig 3: Dietary composition of *E. vittata* in the lower Cross River, Nigeria.

3.6 Seasonal variation in diet composition
The composite diet data for the two seasons was higher in the wet season than the dry season (P>0.05) (Fig. 4). The qualitative food compositions portrayed high dissimilarity in proportions between the seasons.

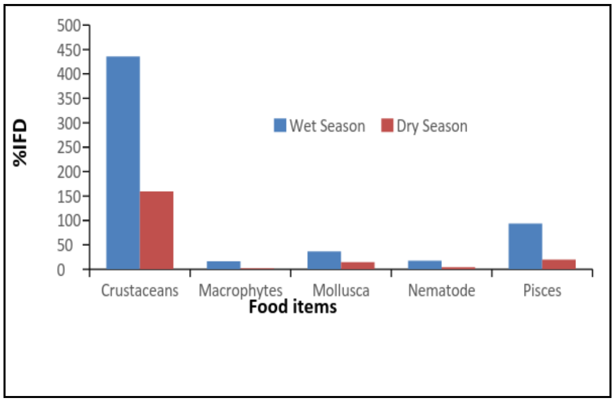

Fig. 4: Seasonal variations in diet composition of *Eleotris vittata* in the lower Cross River, Nigeria.

4. Discussion
In the month of September, only 2 specimens were obtained. This varied slightly with the works [42] who reported on the seasonal distribution and richness of fish species that no specimen of *E. vittata* were recorded in September in the Badagry lagoon. Species abundance describes key elements of biodiversity. Indices of abundance reveal how rare a species is, in relation to other species in a given location or community [43].
Seasonal variation in abundance of *E. vittata* was higher during the wet season than the dry season. This agrees with the findings of [44], who reported that 4339 individuals (or 47.01%) accounting for a biomass of 191371.0g were caught in the dry season while rainy season recorded a total of 4890 individual (52.99%) with a total biomass of 224415.6g; thus, significantly higher catch ($p<0.05$) in the rainy season than dry season. High water season has been considered as the main feeding and growing period for nearly all species in the seasonal flood plain rivers of the tropics [45-49, 44, 50].
E. vittata showed high body condition. The mean condition factor ranging from 1.30 – 1.56 obtained in this study conforms to results from other studies. [51] studied the monthly condition factor of *Eleotris lebretonis* procured from a eutrophic creek in southwest Nigeria for one year and got values of between 1.07 and 2.30. The values obtained from this study showed that the samples were in fair condition all through the sampling period. It therefore implies that life in water with all the potential food resources provide a better environmental condition for *E. vittata* to thrive. In fishery science, body wellbeing ≥ 1.0 is considered as good. Certain factors often affect the well- being of a fish: data pulling, sorting into classes, sex, stages of maturity and state of the stomach, sex, stages of maturity, and state of stomach contents [52, 53].
The months of October and November had the largest fish: 8.10-110.3cm and 8.60-342.70g respectively. The larger sizes of *E. vittata* sampled in these two months could be attributed probably to their faster growth rates and intense feeding habits as observed by [54, 52]. This is a transition phase between the wet and dry seasons; the water level by this time is reducing and food organisms tend to be confined and concentrated in the river channels. The b value determines the growth pattern of a fish: when b is equal to 3 or close to 3, growth is said to be isometric i.e. fish becomes more robust with increasing length [16]. Similarly, when b is far less or greater than 3, growth is allometric i.e. the fish becomes thinner with increase in length [55]. The result of this study showed that the growth of *E. vittata* was negative allometric (0.162). This means that the fish does not grow symmetrically [16] or the fish becomes thinner with increase in length [55]. This observation was similar to documented works from inland water bodies in Nigeria [55, 56, 52, 57, 58]. Length-weight relationships of freshwater fishes are useful in determining weight and biomass when only length measurements are available and are required in fishery management and conservation [59, 60].
The obtained b value of *E. vittata* in this study could be considered to be very low. But, it may be important to note that similar observations have been reported for other fishes fish species such as *S. schall* [56]; *Clarias gariepinus* and *Ilisha africana* [61]. Differences in a and b values have been attributed to the age, sex, fecundity of the fishes, sampling methods and sample size as well as the prevailing ecological conditions in the different water bodies [13]. In addition, b values are also reliant on biological and environmental conditions and geographical, temporal and sampling factors [16, 18]. The correlation coefficient (r) of *E. vittata* was 0.558 indicating a degree of positive correlation between their total lengths and body weights. The implication is that the body weight of the fish increased with increase in body length, but the rate of increase in weight is less than the rate of increase in length.
A total of two hundred and thirty-one stomachs were examined: one hundred sixty-five contained food and sixty-six were without food. The fish species appeared to feed more frequently evidenced by the high percentage of full (32.47%) and partially-filled guts (38.96%) compared to the 28.57% empty gut. The high proportion of the partially-filled and full guts of the fish showed that *E. vittata* is an active feeder. The relatively high percentage of full stomach suggests that food was abundant and available throughout hence, high feeding intensity. The result confirms the observation of [62], who reported that if percentage of full stomach is more than that of empty stomach, there is high degree of feeding intensity.
Nine food items (*Callinectes sp*, *Macrobrachium sp*, *Tympanotonus fuscatus, Pomecia palludosa*, plant leaves, plant seeds, plant roots, nematodes and unidentified fish) which were classified into five major groups (crustaceans, Pisces, Mollusca, macrophytes and nematodes) ingested by *E. vittata*. Fishes of the family Eleotridae are generally known to be voracious predatory carnivores [63, 64]. This predatory habit is manifested in the diet of *E. vittata* in the lower Cross River which feed mostly on diets of animal origin which include crustaceans, Pisces (unidentified fish), molluscs and nematodes. Some plant matters (macrophytes) were also consumed. Crustaceans occurred in guts of all the specimens in all the months of the sampling period. This was followed by Pisces and molluscs though they did not occur in the guts of the fish for June and September. This indicates that they were the most relevant items in the diet of the species during the period of study. [63] observed similar dominance of these food items in their study on the ecology of eleotrid fishes in Central American coastal streams. Nematodes and macrophytes were the least in relevance. The presence of macrophytes could be unavoidably or incidentally ingested by the species being a bottom dweller as reported by [65, 4]; this observation could also be buttressed by its ventral mouth location [46].
The dietary analysis of organisms in their natural habitat enhances the understanding of the growth, abundance,

productivity and distribution of organisms [22]. The knowledge of the diet of a species in nature is important for the establishment of its nutritional needs and of its interaction with other organisms [32] and the presence of various food types (plants, animal, detritus and sediments) in their stomachs is an indication of their feeding habits. Feeding intensity of fish can be determined based on degree of fullness of stomach. Fish can also be further classified into categories based on their predominant feeding habits [46]. Thus, *E. vittata* can be considered as an invertivore-piscivore. This is in agreement with the findings of [66, 67].

5. Conclusion
The present theory of the few occurrence or fish disappearance during the month of September in the different geographical terrain is not clear but should evoke further investigation on *E. vittata*. The fish fed on wide range of food items mostly of animal origin and can therefore be said to be invertivore-piscivore. This study provides new information on the length-weight relationship, condition factor, food and feeding habits of *E. vittata* and has greatly contributed to the knowledge of sustainable fishery resources in the lower Cross River. More qualitative investigations should be carried out in areas of reproduction and in relation to water quality to update this benchmark information.

6. References

1. Nelson JS. Fishes of the world, 4th edition. New York: John Wiley and Sons. 2006; 601-622.
2. Nordlie FG. Feeding and reproductive biology of eleotrid fishes in a tropical estuary. J Fish Biol. 1981; 18:97-110.
3. Nelson JS. Fishes of the world: New York, John Wiley, 1994, 600.
4. Berra TM. Freshwater fish distribution. Academic Press. UK, 2001, 587.
5. Teugels GG, Reid GM, King RP. Fishes of the Cross River Basin (Cameroun-Nigeria). Taxonomy, zoogeography, ecology and conservation. Ani Sci Zool, 1992; 266:1-132.
6. Food and Agriculture Organization (FAO). Species identifications sheets for fisheries purposes. East central Atlantic Fishing Area 34 and Part of 47. Department of Fish and Oceans, Canada 1981, 11.
7. Ewa-Oboho IO. Ecological effects of channelization on a tropical marine ecosystem: Impact on intertidal fish communities in the Cross River, Nigeria. W Afri J Appl Ecol, 2006; 9:1-10.
8. Muto EY, Soares LHS. Rossi-Wongtschowski CLD. Length-weight relationship of marine fish species off Sao Sebastiao system, Sao Paulo, southeastern Brazil. Naga ICLARM Quart, 2000; 23(4):27-29.
9. Kohler N, Casey J, Turner P. Length-weight relationships for 13 species of sharks from the western North Atlantic. Fish Bull, 1995; 93:412-418.
10. Martin-Smith KM. Length/weight relationships of fishes in a diverse tropical freshwater community, Sabah, Malaysia. J Fish Biol. 1996; 49:731-734.
11. Safran P. Theoretical analysis of the weight- length relationships in fish juveniles. Mar Biol, 1992; 112:545-551.
12. Sani R, Gupta BK, Sarkar UK, Pandey A, Dubey V, Lakra WS. Length weight relationship of 14 Indian freshwater species from River Betwa (Yamuna River tributary) and Gomti (Ganga River tributary). J Appl Ichthyo. 2010; 26:456-459.
13. Morato T, Afonso P, Lourinho P, Barreiros JP, Santos RS, Nash RDM. Length-weight relationships for 21 coastal fish species of the Azores, north-eastern Atlantic. Fish Resou, 2001; 50(3):297-302.
14. Singh NO, Sarma D, Singh NG. Length-weight relationship of Tor putitora (Hamilton) from Kosi River Uttarakhand considering different stages of its lifespan. Indian J Fish. 2011; 58:35-38.
15. Thomas J, Venus S, Kurup BM. Length-weight relationship of some deep-sea fish inhabiting continental slope beyond 250m depth along West coast of India. Naga, World Fish Cent Quart, 2003; 26:17-21.
16. Bagenal TB, Tesch FN. Methods for assessment of fish production in fresh waters, 3rd edition London Blackwell Scientific Publication Ltd, 1978, 101-136.
17. Haruna M, Bichi AH. Studies on length-weight relationship and condition factor of the cichlids of Tomas Lake, Kano, Nigeria. Biol Environ Sci J Trop, 2005; 2:94-100.
18. Froese R. Cube law, condition factor and length-weight relationships: History, meta-analysis and recommendations. J Appl Ichthyo. 2006; 22:241-253.
19. Anibeze CIP. Length-weight relationship and relative condition of Heterobranchus longifilis (Valencienness) from Idodo River, Nigeria. Naga ICLARM Quart, 2000; 23:34-35.
20. Oronsaye CG, Nakpodia FA. A comparative study of the food and feeding habits of Chrysichthys nigrodigitatus (Lacepede) and Brycinus nurse in a tropical river. Pak J Sci Ind Res. 2005; 48(2):118-121.
21. Olojo EAA, Olurin KB, Osiikoya OJ. Food and feeding habit of Synodontis nigrita from the Osun River, SW Nigeria. Naga World Fish Cent Quart, 2003; 26:421-424.
22. Fagade SO, Olaniyan CI. The biology of the West African Shad, Ethmalosa fimbriata (Bodwich) in the Lagos Lagoon, Nigeria. J Fish Biol. 1972; 4:519-533.
23. Welcomme RL. River fisheries. FAO Technical Paper 1985; 262:330.
24. Ekpo IE, Udoh JP. Species richness and diversity of ichthyofaunal communities of the lower Cross River floodplain, Nigeria. Int Res J Environ Sci. 2013; 2(7):1-7.
25. King RP. Distribution, abundance, size and feeding habits of Brienomyrus brachyistus (Gill, 1862) (Teleostei: Mormyridae) in a Nigerian Rainforest Stream. Cybium, 1989; 13(1):25-36.
26. Ekpo IE. Ornamental fish species potentials of Ikpa River in Akwa Ibom State, Nigeria. J Biol Agric Healthcare. 2013c; 3(6): 61-66.
27. Tahal Consultants (Nigeria) Ltd. Qua lboe River Basin prefeasibility study Cross River Basin Development authority, Nigeria, 2 Annex, 1979; 11:1-14.
28. Udolisa REK, Solarin BB, Lebo P, Ambrose EE. A catalogue of small scale fishing gear in Nigeria. RAFR Publication, RAFR/041/F1/94/02; 1994; 142Pp.
29. Fagade SO. The food and feeding habits of the fishes of lower River Benue (Nigeria). Bulletin de I'I.F.A.N, 1983; 45:316-341.
30. Ekpo IE, Essien-Ibok MA, Nkwoji JN. Food and feeding habits and condition factor of fish species in Qua Iboe River estuary, Akwa Ibom State, southeastern Nigeria. Int J Fish Aquat Stu. 2014; 2(2):38-46.
31. Schneider W. FAO species identification sheets for fishery purposes. Field guide to the commercial marine

resources of the Gulf of Guinea. Prepared and published with the support of the FAO Regional Office for Africa. FAO, Rome, 1990, 268.

32. Udo MT, Akpan AW. Intersexual and spatial heterogeneity in trophic attributes of the sleeper, Bostrychus africanus (Eleotridae) in the Qua Iboe estuary, Nigeria. Proceedings of the 19th Annual Conference of FISON: 2005, 58-68.
33. Buije AD, Houthuijzen RP. Piscivory, growth, and size-selective mortality of age 0 pikeperch (*Stizostedion lucioperca*). Canandian J Fish Aquat Sci. 1992; 49:894-902.
34. Watson JD, Balon EK. Ecomorphological analysis of fish taxocene of rainforest streams of Northern Borneo. J Fish Biol. 1984a; 25:371-384.
35. Watson JD, Balon EK. Structure and Production of fish communities in tropical rainforest streams of Northern Borneo. Canadian J Zool. 1984b; 62:927-940.
36. Fulton TW. Twenty-second annual report of the Fishery Board for Scotland, being for the year 1903. Part III. Scientific investigations. James Hedderwick & Sons, the Citizen Press, Glasgow, UK. 1904, 241.
37. Hynes HBN. The food of freshwater sticklebacks (Gasterosteus aculeatus and Pygosteus pungitius) with a review of methods used in studies of the food of fishes. J Ani Ecol. 1950; 19:26-28.
38. Nataragan AV, Jhingram AG. Index of preponderance – A method of grading the food elements in the stomach analysis of fishes. Indian J Fish. 1961; 8:54-59.
39. Hyslop EJ. Stomach content analysis: A review of methods and their application. J Fish Biol. 1980; 122:71-80.
40. Udo MT, Akpan AW, Larson H. Ontogenetic shift in the diet of foraging behaviour of the Schlegel’s Goby, Porogobius schlegelii (Gobiidae) in the Qua Iboe estuary, Southeastern Nigeria. J Aquat Sci. 2008; 23(1):77-86.
41. King RP. New observations on the trophic ecology of *Liza* grandisquamis (Valenciennes, 1836) (Pisces: Mugilidae) in the Bony River, Niger Delta, Nigeria. Cybium, 1988; 12(1):23-36.
42. Soyinka OO, Kutona MP, Ayo-Olalusib CI. Seasonal distribution and richness of fish species in the Ba dagry lagoon, south-west Nigeria. Estonian J Ecol. 2009; 59:147-157.
43. Williams F. Report on Guinean trawling survey. Pubish. Scient. Tech. Res. Comm. Organ. Afr. J. 1968; 1:99-132.
44. Meye JA, Ikomi RB. Seasonal fish abundance and fishing gear efficiency in River Orogodo, Niger Delta, Nigeria. World J Fish Mar Sci. 2012; 4(2):191-200.
45. Lowe-McConnell RH. Fish communities in tropical waters: their distribution, ecology and evolution. 1st edition, Longman, London. 1975, 152-175.
46. Welcomme RL. Fisheries ecology of Floodplain Rivers. 1st edition, London. Longman Press, 1979, 15-45.
47. Ikomi RB, Odum O, Erueseraise M. Fish communities of the Ovwere Stream in the Niger Delta Area, Nigeria. Acta Ichthyologica et Piscatoria, 1997; 27:113-125.
48. Olukolajo SO, Oluwaseun KA. Seasonal variation in the distribution and fish species diversity of a tropical lagoon in South-West Nigeria. J Fish Aquat Sci, 2008; 3:375-383.
49. Tejerina-Garro FL, De Merrona B. Flow seasonality and fish assemblage in tropical river, French Guiana, South America. Neotrop Ichthyo, 2010; 8:1-16.
50. Ekpo IE, Obot OI, Essien-Ibok MA. Studies on the food composition and feeding pattern of fish communities in Qua Iboe River, Niger Delta region of Nigeria. American J Biol Life Sci. 2014; 2(5):122-134.
51. Chukwu LO, Kuton MP. The bio-ecology of the goby, Eleotris lebretonis (Steindachner) (Pisces: Eleotridae) from a Eutrophic creek in Southwestern Nigeria. J Sci Techn Environ. 2001; 1:67-76.
52. Abowei JFN, Hart AI. Some morpho-metric parameters of ten species from the Lower Nun River, Niger Delta. Res J Biol Sci. 2009; 4(3):282-288.
53. Gayanilo FC, Pauly D. FAO-ICLARM stock assessment tools (FISAT), reference manual. FAO computerized information series (Fisheries). Rome, FAO, 1997; 8:262.
54. Idodo-Umeh G. The feeding ecology of Mochokid species in River Ase, Niger Delta, Nigeria. Trop Freshwat Biol, 2005; 14:71-93.
55. King RP. Population dynamics of the mud skipper, Periophthalmus barbarus (Gobiidae) in the estuarine swamps of Cross River, Nigeria. J Aquat Sci. 1996; 11:31-34.
56. Olatunde A. Length – weight relationships and the diets of Malapterurus electricus (Gmelin) in Zaria. Rev Zool Afri, 1984; 98:261-274.
57. Ibrahim BU, Auta J, Balogun JK. A survey of the artisanal fisheries of Kontagora Reservoir, Niger State, Nigeria. Bayero J Pure Appl Sci. 2009; 2(1):47-51.
58. Ude EF, Ugwu LL, Mgbenka BO. Evaluation of zooplankton diversity in Echara River, Nigeria. Contin J Biol Sci. 2011; 4(1):1-5.
59. Froese R. Length-weight relationships for 18 less-studied fish species. J Appl Ichthy. 1998; 14:117-118.
60. Oscoz J, Campos F, Escala MC. Length-weight relationships of some fish species of the Iberian Peninsula. J Appl Ichthy. 2005; 21:73-74.
61. Fafioye OO, Oluajo OA. Length-weight relationships of five fish species in Epe Lagoon, Nigeria. Afri J Biotechn, 2005; 4:749-751.
62. Ogbeibu AE, Ezeunara PU. Studies on the food composition and feeding pattern of fish communities in Ikpoba River, southern Nigeria. J Aquat Sci. 2005; 20(2):117-129.
63. Winemiller KO, Ponwith BJ. Comparative ecology of eleotrid fishes in Central American coastal streams. Environ Biol Fish, 1998; 53:373-384.
64. Dankwa HR, Abban EK, Teugels GG. Freshwater fishes of Ghana: Identification, distribution, ecological and economic importance. Annal Sci Zool, Muse Royale de L’Afrique Centrale, 1999; 283:1-53.
65. Graham JB. Air-breathing fishes: Evolution, diversity, and adaptation. San Diego, California, Academic Press. 1997, 299.
66. Allen GR, Robertson DR. Fishes of the tropical Eastern Pacific. University of Hawaii Press, Honolulu, 1994, 332.
67. Maeda K, Tachihara K. Instream distributions and feeding habits of two species of sleeper, Eleotris acanthopoma and Eleotris fusca in the Teima River, Okinawa Island. Ichthyol Res, 2004; 51(3):233-240.