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Research Article
Trophic Ecology of the Reed Fish, *Erpetoicthys calabaricus* from a Niger Delta Creek, Nigeria

[1]Asuquo Idopise Abasi Ekpe and [2]Essien-Ibok Mandu Asikpo

[1]Department of Fisheries and Aquaculture, Akwa Ibom State University, Nigeria
[2]Department of Fisheries and Aquatic Environmental Management, University of Uyo, Nigeria

Abstract

Background and Objective: Considering the "near threatened" status of *E. calabaricus*, consequent upon habitat degradation from anthropogenic perturbations and total lacuna of literature and data on the trophic biology of the species, there was dire need to research on this aspects of its ecology. Thus, this study was carried out in other to compute data on food and feeding habits if the species. **Materials and Methods:** Six hundred and thirty four specimens were analyzed. Fish samples were obtained by sampling bi-monthly between April, 2013 and March, 2014. Samples were immediately preserved in 10% formalin solution for laboratory analysis. To evaluate feeding activity of *E. calabaricus*, the "points" method and gut repletion index (GRI) were used. Each intestinal bulb was assigned a number of points proportional to its degree of fullness according to an arbitrary 0-20 scale. Thus 0, 5, 10, 15 and 20 points were scored for empty, 1/4 full, 1/2 full, 3/4 full and full intestinal bulbs, respectively. Intermediate points were also scored where necessary. Mean point per gut, i.e., average gut fullness (AGF) was then calculated. The percentage occurrence of non-empty gut was computed to show the GRI. The gut contents of each specimen were dispersed with few drops of water in a Petri-dish and examined macroscopically with the naked eyes and microscopically under a dissecting microscope. The food items were sorted and identified to the lowest taxon possible with the aid of standard keys and descriptions. The relative importance of the dietaries was assessed by the points and frequency methods. Volume of gut fullness was shared among the gut contents in units proportional to their bulk (estimated visually). The total points per food item were then expressed as a percentage of grand total points scored by all food items. **Results:** The gut contents revealed that 10 food items were ingested and categorized into 6 major groups viz Algae, Crustacea, Insecta, Nematoda, Pisces and Detritus. Algae comprised blue green algae (*Annabella* sp.). Crustaceans consisted of *Macrobrachium* sp. and shrimp remains. Insecta included diptera, coleoptera and insect remains. The Nematoda group consisted of earthworm and its remains. Pisces included fish remains (bones and scales). Detritus was made up of coarse particulate organic matter (CPOM) and fine particulate organic matter (FPOM). Food ponderance index (FPI) showed that *E. calabaricus* fed primarily on insecta (44.70%), crustacea (39.13%) and worms (15.15%) as dominant food items, while Algae (0.41%), pisces (0.60%) and detritus (0.01%) were ingested as incidental items. **Conclusion:** Findings suggests that the high relative importance and abundance of insects, crustaceans and Nematoda in diets of the fish suggests invertivorous foraging with narrow trophic spectrum.

Key words: Food, gut, trophic, dietaries, dominant, fullness, ingested

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Corresponding Author: Asuquo Idopise Abasi Ekpe, Department of Fisheries and Aquaculture, Akwa Ibom State University, Nigeria Tel: +2348085944125

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Food is the basic prerequisite for growth, development, survival and existence of all organisms. It plays an important role in the migration and spawning behaviour of the fish[1]. The study of the food and feeding habits of freshwater fish species is a subject of continuous research because it constitutes the basis for the development of a successful fisheries management programme[2]. The identification of stomach contents allows knowledge on food consumption, feeding and assimilation rates, cannibalism and even habitat segregation[3]. Extensive works have been done by several authors[4-6] on trophic attributes of fresh and brackish water species. They have noted fishes divided into herbivorous, omnivorous and carnivorous feeding habits, some of the reports have categorized the fishes as surface, mid and bottom feeding in different water bodies of the world.

Factors like size, age, sex, life history stage, time of feeding and food available have been identified as being critical as they affect the food quality of fishes in the tropics[7-10]. Similar investigations had shown that the natural food of fish tend to vary quantitatively and qualitatively with seasons of the year[11,12]. The study of dietary habits based on stomach content analysis is widely used in fish ecology as an important means of investigating trophic relationship in the aquatic communities[13] and in the creation of trophic models as a tool to understanding complex ecosystems[14]. *Proptopterus* sp., a related fish to the study species has been classified as omnivore, feeding mainly on fishes besides other items like insects, crustaceans, annelids, mollusks, detritus and plant materials[15-17]. Despite of all these studies, there is no literature on qualitative and quantitative items in gut contents of the *E. calabaricus* species hence the dire need for this study. The study attempts to present baseline data on dietary habits and composition of the study species.

MATERIALS AND METHODS

Study area: The study was conducted in Ibikpe creek (Fig. 1) situated (latitude 05°6'N and longitude 08°11'E) within the

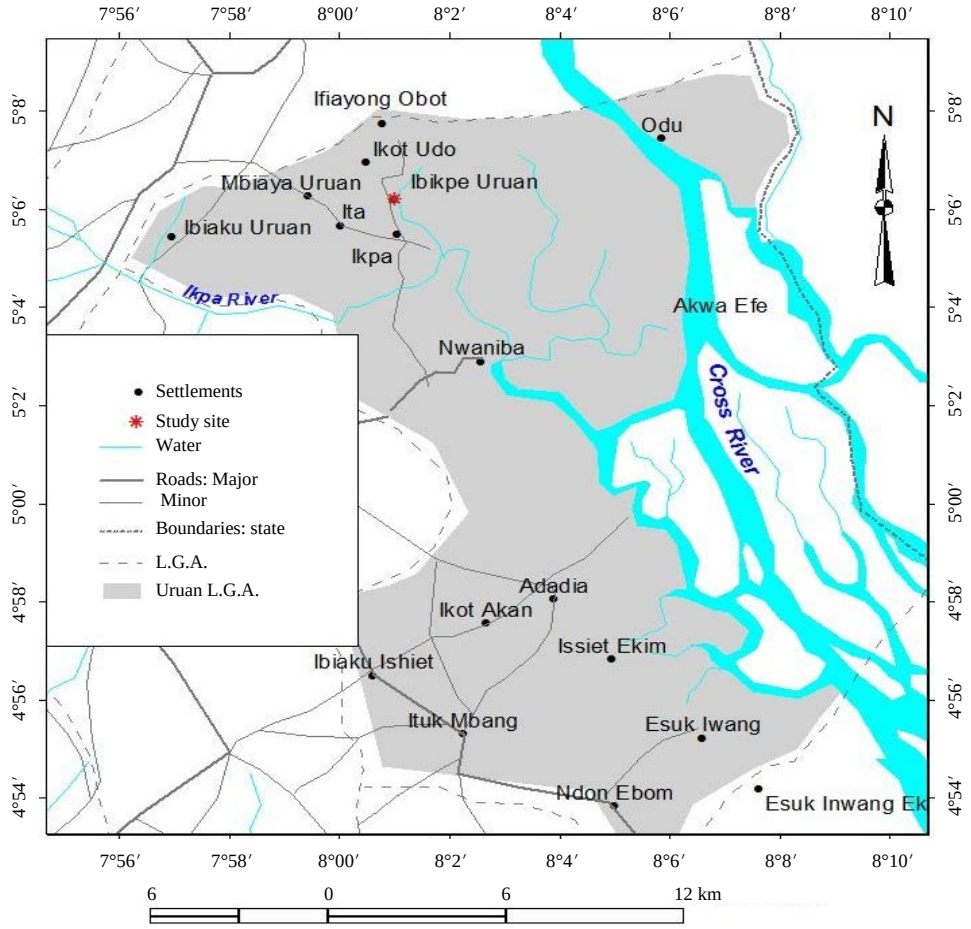

Fig. 1: Location of study area on map of Uruan local area
Source: Google earth map

rainforest zone of south-eastern Nigeria, located west of the lower reaches of the Cross River System. The creek is a perennial forest tributary system and drains a catchment area of 318.9 km^2 (liable to annual flooding) into the cross river system. The area forms part of the Atlantic drainage system east of the Niger. It comprises dry (November-March) and wet (April-October) seasons[18-20].

Sample collection and laboratory procedure: Samples of *E. calabaricus* were collected from designated fishers bi-monthly between April, 2013 and March, 2014 by means of non-return valve basket traps (baited with palm fruits) set on the flood plains at three locations located 2-7 m deep and 10 m close to the shore. Traps were 42-50 cm in length, 14-17 cm diameter of opening with mesh sizes of 0.2-0.5 cm. In the laboratory, each specimen was dissected to remove the gut. The entire stomach of the fishes was removed and graded.

Data collection and analysis: To evaluate feeding activity of *E. calabaricus*, the "points" method[21] and gut repletion index (GRI) were used. Each intestinal bulb was assigned a number of points proportional to its degree of fullness according to an arbitrary 0-20 scale. Thus 0, 5, 10, 15 and 20 points were scored for empty, 1/4 full, 1/2 full, 3/4 full and full intestinal bulbs, respectively. Intermediate points were also scored where necessary. Mean point per gut, i.e., average gut fullness (AGF) was then calculated. The percentage occurrence of non-empty gut was computed to show the GRI. The gut contents of each specimen were dispersed with few drops of water in a petri-dish and examined macroscopically with the naked eyes and microscopically under a dissecting microscope. The food items were sorted and identified to the lowest taxon possible with the aid of keys and descriptions provided[22-25]. The relative importance of the dietaries was assessed by the points and frequency methods. Volume of gut fullness was shared among the gut contents in units proportional to their bulk (estimated visually). The total points per food item were then expressed as a percentage of grand total points scored by all food items as provided by King *et al.*[26] thus:

$$PP = \sum_{i=1}^{p_i} P_i \; n \times 100 \quad (1)$$

where, PP is the percentage points, p_i is the points allotted to item I, P_i is the overall points of the nth item (sum of all p_i). The relative frequency (RF) of each item was computed thus[18]:

$$RF = \sum_{i=1}^{f_i} F_i \; n \times 100 \quad (2)$$

where, f_i is the frequency of the item i, F_i is the frequency of the nth item (sum of all f_i). The integrated importance of each item was then expressed by food ponderance index (FPI)[26]:

$$FPI = \frac{RF.PP}{\sum(RF.PP)} \times 100 \quad (3)$$

The index ranges from 0-100%. Items with FPI$\geq$10% were arbitrarily considered as dominant food items, those with FPI 1-9.9% as secondary and those with FPI<1% were considered as incidental. The use of FPI to establish overall food preponderance is adequate as it incorporates the PP and RF data, thus minimizing the bias characteristics of cases in which results from different analytical methods are independently interpreted[26]. Diet breath was calculated on PP and RF data on Simpson[27] diversity index (D) derived from the formulation:

$$D = 1 - \sum_{i=1} (n_i / N)^2 \quad (4)$$

where, n_i is the percentage point or relative frequency of item i, N is the total RF or PP of the jth item. Temporal, seasonal and inter-sexual variations in the relative importance of the food items were analyzed by the d-statistics[28].

RESULTS

Feeding intensity: Out of the 634 specimens of *E. calabaricus* (21.0-39.9 cm TL) examined for food and feeding habits, 416 (65.61%) had completely empty guts (EG), 210 (33.12%) were partially filled guts (PG) and 8 (1.27%) were full guts (FG). Monthly number and sizes of *E. calabaricus* examined for food is shown in Table 1.

Diet composition: The overall gut contents of *E. calabricus* (Table 2) revealed that 10 food items were ingested. The food items were re-categorized into six major groups viz Algae, Crustacea, Insecta, Nematoda, Pisces and Detritus. Algae comprised blue green algae (*Annabella* sp.). Crustaceans consisted of *Macrobrachium* sp. and shrimp remains. Insecta included diptera, coleoptera and insect remains. The Nematoda group consisted of earthworm and its remains. Pisces included fish remains (bones and scales). Detritus was made up of coarse particulate organic matter (CPOM) and fine particulate organic matter (FPOM). Food ponderance index (FPI) showed that *E. calabaricus* fed primarily on insecta (44.70%), crustacea (39.13%) and worms (15.15%) as dominant food items, while algae (0.41%), pisces (0.60%) and detritus (0.01%) were ingested as incidental dietaries.

Table 1: Monthly number and sizes of *E. calabaricus* in Ibikpe creek examined for food

Month	No. of examined	No. with food	Total length (cm)	Total weight (g)	EG (%)
April	34	19	21.0-35.2	14.59-54.18	44.12
May	61	24	24.1-36.5	23.32-74.32	60.66
June	58	37	25.0-35.4	28.02-74.08	39.66
July	62	18	23.0-34.2	18.02-60.94	72.13
August	62	19	26.2-39.9	28.40-52.47	69.35
September	61	18	21.7-32.19	17.07-76.08	72.13
October	61	13	23.0-33.6	20.92-61.71	78.69
November	63	19	23.3-36.0	23.25-64.62	71.43
December	60	21	22.2-33.7	17.65-60.92	63.33
January	58	18	22.3-32.5	16.33-48.80	70.69
February	39	7	21.8-31.5	18.46-55.68	82.05
March	16	5	22.5-33.5	18.66-60.84	68.75

EG: Empty guts

Table 2: Overall trophic spectrum of *E. calabaricus* in Ibikpe creek

Food items	Food ponderance index (FPI%)
Algae	
Annabella sp.	0.41
Crustacea	
Macrobrachium sp.	8.72
Shrimp remains	30.41
Total	39.13
Insecta	
Diptera	4.63
Coleoptera	5.36
Insect remains	34.71
Total	44.7
Nematoda	
Earthworm	2.66
Worm remains	12.49
Total	15.15
Pisces	
Fish remains	0.60
Detritus	0.01

Table 3: Monthly variations in the food ponderance index of *E. calabaricus* in Ibikpe creek

	Food ponderance index (%)											
Food items	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Algae												
Annabella sp.	0.11	0.33	0.60	0.19	1.05	0.52	2.65	1.70	-	-	-	-
Crustacea												
Macrobrachium sp.	4.43	13.39	3.75	11.70	5.26	3.87	6.49	11.32	5.82	6.41	7.70	6.97
Shrimp remains	12.66	25.10	30.63	24.37	40.0	39.69	44.25	44.91	27.14	25.64	38.46	11.63
Total	17.09	38.49	34.38	36.07	45.26	43.56	50.74	57.93	32.96	32.05	46.16	18.60
Insecta												
Diptera	6.33	2.51	5.26	11.70	3.51	0.64	4.13	12.83	2.50	1.28	5.77	11.63
Coleoptera	6.33	6.13	2.10	3.90	10.53	5.80	4.72	4.90	9.12	3.85	13.46	11.63
Insect remains	42.19	27.89	41.67	29.24	33.16	35.18	23.60	13.58	47.21	43.27	5.77	37.21
Total	54.85	36.53	49.03	44.84	47.20	41.62	32.45	31.31	58.83	48.40	25.00	60.47
Nematoda												
Earthworm	3.16	3.35	4.50	1.95	1.05	2.57	1.18	1.51	0.46	3.85	26.92	4.65
Worm remains	22.15	21.08	11.41	15.59	5.26	11.60	11.80	8.50	7.29	14.42	1.92	9.30
Total	25.31	24.43	15.91	17.54	6.31	14.17	12.98	10.01	7.75	18.27	28.84	13.95
Pisces												
Fish remains	2.64	0.22	0.04	1.17	0.18	0.13	1.18	0.75	0.46	1.28	1.92	4.65
Detritus	-	-	0.04	0.19	-	-	-	-	-	-	-	2.33

Temporal regimes in diet composition: Monthly food ponderance index (FPI%) (Table 3) showed that Crustacea, Insecta and Nematoda occurred as dominant food items in all months, except in August and December where Nematoda was ingested as secondary items. Algae predominated in August, October and November as secondary items and were

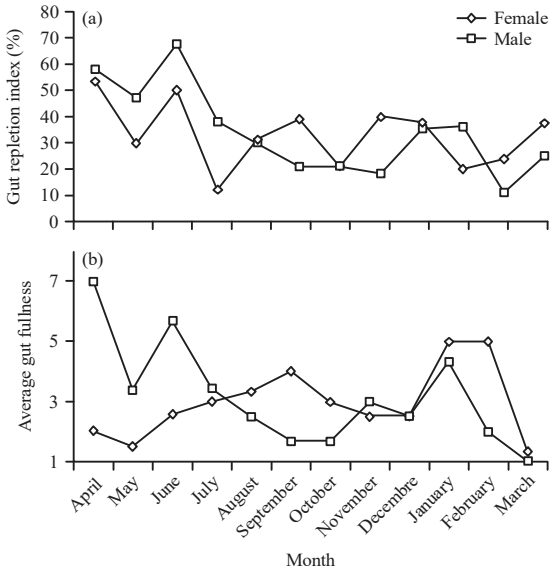

Fig. 2(a-b): Monthly changes in indices of feeding activity of *E. calabaricus* in Ibikpe creek

ingested in April-July and September as incidental items. Fish remains were ingested in May, June, August, September, November and December as incidental items except in April, July, October and January-March where they served secondary importance in the diets. Detritus was mostly ingested in June and July with incidental importance and in March where it served secondary importance in the diet.

Temporal regimes in feeding activity: Monthly variations in feeding activity of *E. calabaricus* are illustrated in Fig. 2. With the exception of the early drop in mean gut repletion index (GRI) in May, the monthly changes in gut fullness indices followed similar patterns, the GRI peaked in June and December while peaks of average gut fullness (AGF) occurred in June, September and January. This result suggests that higher feeding activity occurred in May-July, August-October, November-February while lowest feeding activity occurred in March and April.

DISCUSSION

Qualitative and quantitative composition of fish diets is important to growth, maturity and fecundity changes in fish amongst other factors. Study of dietary habits of fish based on stomach content analysis is widely used in fish ecology as an important means of investigating trophic relationships in aquatic communities[29]. The *E. calabaricus* from Ibikpe creek fed primarily on various groups of Insecta, Crustacea and Nematoda as dominant food items while Algae, Pisces and detritus were ingested as incidental items. This result agrees with the studies of Offem *et al*.[30], who documented that the fish under study showed preference for prawns, detritus and insects, but however further reports by same authors noted that *Polypterus senegalensis*, a close relative of *E. calabaricus* being of same family fed on fish fry, insects and frogs. The reason for this could be because all the diets reported are of faunal origin. Raji *et al*.[31] also documented that fish remains, insects and detritus were found in the diets of *P. endlichri* and *P. senegalus* in Lake Chad, which are as well very close family members of *E. calabaricus*. The above finding corroborates the present findings except that the order of relative importance and range of the food items ingested by *E. calabaricus* in Ibikpe creek is appreciably higher than those reported by Offem *et al*.[6] in their location which could as well cause the difference.

The gut contents of *E. calabaricus* from Ibikpe creek depicted predominantly benthic foraging while the food spectrum portrayed high tropical flexibility as earlier reported by Offem *et al*.[30] and Udo *et al*.[4] of tropical species, though with a narrow diet diversity. Flexibility in diet preference enables the fish to switch easily from one food category to another in response to fluctuations in their abundance. Another possibility is the ability of the species to ingest and utilize different food items effectively. This was accentuated by the high proportion of non-empty guts as discovered from the studies. The monthly and seasonal dynamics in the relative importance of the items ingested by *E. calabaricus* from Ibikpe creek are probably due to the temporal patterns in the availability and abundance of the food items. The reliance of *E. calabaricus* on Crustacea, Insecta and Nematoda as primary and dominant dietary components throughout the year is probably facilitated by the vast mangrove swamp[32] which ensures a constant allochthonous input of these items.

The large proportion of empty guts in specimens of *E. calabaricus* from Ibikpe creek could be due to in-frequent feeding[6] related this to the low abundance of the species in the area. Although the frequency of empty guts was relatively high during the raining season, which seems to be associated with breeding activity. As suggested earlier, rainfall and subsequent rise in water level trigger spawning[33] as reported for other tropical species. Thus, the fish may have been more engaged in spawning activity than in feeding activity. Similar findings and conclusions have been reported for other species[33]. The other reason that could have been responsible for high occurrence of empty guts is the method of capture. Since the fish were left for several hours on the gears before they were collected, the gut contents may have been lost by regurgitation or digestion. Seasonality in indices of gut fullness of *E. calabaricus* indicated a higher feeding activity in

the wet season than the dry season, a pattern consistent with tropicalspecies[34]. The precise reason is uncertain but could reflect an adaptation linked to reproduction and ensuring that the progeny hatch into more favorable feeding condition of improved food resources at onset of the dry season as observed in the present study.

The study also revealed that the relative importance of large-sized items such as Crustacea, fish remains (scales and bones), Nematoda and Insecta in the dietaries of the species was not a function of fish size. Larger food items were ingested in the levels proportional to fish size, while that of small-sized such as algae and detritus were ingested incidentally. The inherent increase in mouth gape with body growth of the fish probably permits the prey-size related feeding pattern by *E. calabaricus*. The ecological significance of the diversification in the fish diet with growth is to minimize intra-specific competition and offers a wider spectrum of food resources for exploitation[35].

CONCLUSION

The present study has presented baseline first hand in-depth data on trophic attributes of *E. calabaricus* in Ibikpe where there was none, including other water bodies. The continuous disappearance of this species could be attributed to environmental factors and other natural causes threatening the species and its ecology which lack of adequate and dietaries form part. Further studies might determine other critical parameters such as sex ratio, condition factor, population dynamics and sexual dimorphism of the species.

SIGNIFICANCE STATEMENT

The study discovered that the large proportion of empty guts in specimens from Ibikpe creek was due to in-frequent feeding which consequently affected the abundance of the species in the area. Information and adequate knowledge of this aspect of the biology of the species as discovered by this research would to a large extent help other researchers determine the commercial productivity and aquaculture of the species. Therefore, this study would form a mile stone and foundation on other parameters that would be further researched on the species.

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REFERENCES

1. Bhuiyan, A.S., S. Afroz and T. Zaman, 2006. Food and feeding habit of the juvenile and adult snakehead, *Channa punctatus* (Bloch). J. Life Earth Sci., 1: 53-54.
2. Oso, J.A., I.A. Ayodela and O. Fagbuaro, 2006. Food and feeding habits of *Orechromis niliticus* (L.) and *Sarotheroden galilaeus* (L.) in a tropical reservoir. World J. Zool., 1: 118-121.
3. Gumus, A., M. Yilmaz and N. Polat, 2002. Relative importance of food items in feeding of *Chondrostoma regium* Heckel, 1843 and its relation with the time of annulus formation. Turkish J. Zool., 26: 271-278.
4. Udo, M.T., A.W. Akpan and H. Larson, 2008. Ontogenetic shift in the diets and foraging behaviour of the schlegel's Goby *Porogobius schlegelii* (Gobiidae) in the Qua Iboe Estuary, South-Eastern Nigeria. J. Aquat. Sci. 23: 77-86.
5. Omondi, R., A.W. Yasindi and A. Magana, 2015. Spatial and temporal variations of zooplankton in relation to some environmental factors in lake Baringo, Kenya. Egerton J. Sci. Technol., 11: 29-50.
6. Offem, B.O., Y.A. Samson and I.T. Omoniyi, 2009. Trophic ecology of commercially important fishes in the cross river, Nigeria. J. Anim. Plant Sci., 19: 37-44.
7. Araoye, P.A. and C.Y. Jeje, 1999. The diet of *Synodontis schall* (Bloch and Schneider 1801) in Asa Dam, Ilorin, Nigeria. Nig. J. Sci., 33: 67-76.
8. Ezenwaji, H.M.G., 2002. The biology of *Clarias ebriensis* Pellegrin, 1920 (Osteichthyes: Clariidae) in an Africa rain forest river basin. Fish. Res., 54: 235-252.
9. Ezenwaji, H.M.G. and F.N. Offiah, 2003. The biology of *Pellonula leonensis* boulenger, 1916 (Osteichthyes: Clupeidae) in Anambra River, Nigeria. J. Bio-Res. Biotechnol., 1: 33-50.
10. Owolabi, O.D., 2005. Some aspects of the biology of *Synodontis membranaceus* Geoffroy Saint Hilarie in Jebba lake, Nigeria. Ph.D. Thesis, University of Ilorin, Nigeria.
11. Ugwumba, A.A.A. and A.A. Adebisi, 1992. The food and feeding ecology of *Sarotherodon melanotheron* (Rupell) in a small freshwater reservoir in Ibadan, Nigeria. Arch. Hydrobiol., 124: 367-382.
12. Ekpo, A.O., 1993. Growth, feeding and reproductive biology of *Hydrocynus forskalii*, *Alestes macrolepidotus* and *Channa obscura* in Asejire reservoir, Nigeria. Ph.D. Thesis, University of Ibadan, Ibadan.
13. Arendt, M.D., J.E. Olney and J.A. Lucy, 2001. Stomach content analysis of cobia, *Rachycentron canadum*, from lower Chesapeake bay. Fish. Bull. Nat. Oceanic Atmos. Admin., 99: 665-670.
14. Lopez-Peralta, R.H. and C.A.T. Arcila, 2002. Diet composition of fish species from the southern continental shelf of Colombia. Naga World Fish Center Q., 25: 23-29.
15. Corbet, P.S., 1961. The food of non-cichlid fishes in the Lake Victoria Basin, with remarks on their evolution and adaptation to lacustrine conditions. Proc. Zool. Soc. London, 136: 1-101.

16. Oniye, S.J., D.A. Adebote, S.K. Usman and J.K. Makpo, 2006. Some aspects of the biology of *Protopterus annectens* (Owen) in Jachi dam near Katsina, Katsina state, Nigeria. J. Fish. Aquatic Sci., 1: 136-141.
17. Adeyemi, S.O., N.O. Bankole and A.I. Adikwu, 2009. Food and feeding habits of *Protopterus annectens* (Owen) in Gbedikere lake, Bassa, Kogi state, Nigeria. Cont. J. Biol. Sci., 2: 7-11.
18. King, R.P., 1989. Distribution, abundance, size and feeding habits of *Brienomyrus brachyistius* (Gill, 1862) (Teleostei: Mormyridae) in a Nigerian rainforest stream. Cybium, 13: 25-36.
19. Teugels, G.G., G.M. Reid and R.P. King, 1992. Fishes of the cross river basin (Cameroon Nigeria) taxonomy, zoogeography, ecology and conservation. Ann. Sci. Zool., 266: 132-132.
20. Udoidiong, O.M. and R.P. King, 2000. Ichthyofaunal assemblages of some Nigerian Rainforest streams. J. Aquat. Sci., 15: 1-8.
21. Hyslop, E.J., 1980. Stomach contents analysis-A review of methods and their application. J. Fish. Biol., 17: 411-429.
22. Davis, C.C., 1955. The Marine and Freshwater Plankton. Michigan State University Press, Michigan, USA., Pages: 562.
23. Huynh, M. and N. Serediak, 2006. Algae Identification Field Guide. Agriculture and Agriculture Food Press, Canada, pp: 40.
24. Witty, L.M., 2004. Practical Guide to Identifying Freshwater Crustacean Zooplankton. Laurentian University: Cooperative Freshwater Ecology Unit, Laurentian, pp: 60.
25. Winterbourne, M.J. and K.L.D. Gregson, 1981. Guide to aquatic insects of New Zealand. Ento. Soc. New Zeal. Bull., 5: 1-8.
26. King, R.P., O.M. Udoidiong, E.C. Egwali and N.A. Nkanta, 1991. Some aspects of the trophic biology of *Ilisha Africana* (*Teleostei*, *Pristigasteridae*) in Qua Iboe Estuary, Nigeria. J. Afr. Zool., 105: 261-274.
27. Simpson, A.C., 1959. Method used for separating and counting the eggs and fecundity studies on the plaice (*Pleuronectes platessa*) and herring (*Clupea herengus*). Occasional Paper, No. 59112. FAO Indo-Pacific Fish Count, Rome.
28. Bailey, N.T.J., 1959. Statistical Methods in Biology. The English Universities Press Ltd., London, Pages: 200.
29. Fagbenro, O., C.O. Adedire, E.O. Ayotunde and E.O. Faminu, 2008. Haematological profile, food composition and digestive enzyme assay in the gut of the African bony-tongue fish, *Heterotis* (Clupisudis) *niloticus* (Cuvier 1829) (Osteoglossidae). Trop. Zool., 13: 1-9.
30. Offem, B.O., Y. Akegbejo-Samsons and I.T. Omoniyi, 2008. Diet, size and reproductive biology of the silver catfish, *Chrysichthys nigrodigitatus* (Siluformes: Bagridae) in the Cross River, Nigeria. Revista Biologia Tropical, 56: 1785-1799.
31. Raji, A., K.S. Armed and T.M. Ahmed, 2004. Preliminary studies on the food and feeding habits of *Polypterus endlicheri* and *Polypterus senegalus* in lake Chad. Proceedings of the 18th Annual Conference of Fisheries Society of Nigeria, December 8-12, 2003, Owerri, Nigeria, pp: 186-193.
32. Enplan Group, 1974. Imo river basin pre-feasibility report. Federal Ministry of Agriculture, Vol. 11, Lagos, pp: 45.
33. Zenebe, T., 1998. Food and feeding ecology of tilapia, *Oreochromis niloticus* L. and effects of diet on the lipid quality of the fish in some lakes in Ethiopia. Ph.D. Thesis, School of Graduate Studies, Addis Ababa University, Addis Ababa.
34. Tejerina-Garro, F.L. and B. de Merrona, 2010. Flow seasonality and fish assemblage in a tropical river, French Guiana, South America. Neotrop. Ichythyol., 8: 145-154.
35. Onimisi, H.U., S.J. Oniye, J.K. Balogun and T.O.L. Aken'Ova, 2009. Food and feeding habits of *Auchenoglanis occidentalis* (Vallenciennce, 1840) in Zaria, Nigeria. Zoologist, 7: 57-64.