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TROPHIC ECOLOGY OF COMMERCIALLY IMPORTANT FISHES IN THE CROSS RIVER, NIGERIA

B. O. Offem, Y. A.Samsons[*] and I. T. Omoniyi[*]

Department of Animal Science & Fisheries, Faculty of Agrculture & Forestry, Cross River University of Technology, Obubra Campus, Cross River State, Nigeria.
[*]Department of Aquaculture and Fisheries Management, University of Agriculture, Abeokuta, Nigeria
Corresponding author's email: benbeff06@yahoo.com

ABSTRACT

Diet composition, Food Richness, Diet Breadth and Gut Repletion Index of 47 fish species belonging to 28 genera and 16 families consisting of 14,837 individuals in the inland wetlands of Cross River, Nigeria, were studied monthly between January 2006 and December 2007. There was variation in the composition of food objects in the different species despite the similarity in the rank-order (r_s= 0.996, p > 0.004). Major food item in the diet of the 46 species consist of detritus (79.9%), fish and fish fry (41.3%), insect and insect larva (41.3%), phytoplankton (26.1%), crustaceans (23.9%), mollusk (13%), macrophytes parts (13 %), seeds (10.9%), worms (0.04%), arachnids (0.02%) and amphibians (0.02%). Food Richness (N) varied between 5 and 20, Diet Breadth (D) from 0.22 to 0.88 and Gut Repletion Index (GRI) between 34% and 100%. This implies that most of the fish species in Cross River are detritivores with high feeding intensity and trophic flexibility, hence are capable of changing diet according to availability.

Key Words: Diet composition, Food richness, Gut Repletion Index, Ichthyofauna, Diet breadth, Diet similarity.

INTRODUCTION

Freshwater wetlands contribute about 40 % of fin fishes caught in Nigerian waters annually (Welcome, 1976). However, resources enjoyed by the wetland communities are being gradually depleted. It is therefore, urgently needed to conserve the resources and develop the fishery of inland wetlands in the country.

Over the years aquaculture had gained a rapid interest due to the importance of fish as a cheap source of animal protein. Fish, like any animal require adequate nutrition for proper growth and survival. In the wild, nature offers a great diversity of food including a host of animals and plants. However, in ponds natural food is not sufficient to sustain the fish especially in high density ponds. Therefore, for efficient and cost effective fish farm management, there is need for effective nutritional strategies, which can only be achieved via proper understanding of the food and feeding habits of the fish to be cultured. However, little information exist (Inyang and Nwani, 2004; Idodo-Umeh, 2002) on the diets of fresh water fishes in Nigerian waters despite their commercial importance.

The decline in the abundance of fresh water fish resources is always an issue in the fishing industries in Nigeria (Etim, 1993; Etim and Akpan, 1993; Akpan, 1994; Akegbejo-Samsons, 1995). The declining trend is thought to prevail due to either over-exploitation of the fish resources with bad fishing methods like explosives and poisoning or factors relating to availability of food in the area (Ita *et al*., 1985 and Moses, 1995). Analysis of the stomach content of fish could provide information about the niche of the particular fish in its ecosystem (Pillay, 1952). It contributes a better understanding of the trophic dynamics and food webs, which is essential for appropriate fisheries management. Studies on food and feeding habits gives information on seasonal changes of fish because the type and magnitude of food available as well as the season it occurs plays important role in the history of the fish (Akpan and Isangedhi, 2005). There are reports (Ahmad, 1980, Hadzley, 1997; Khan *et al*., 2008) that discuss these issues but the distribution of fish as related to the distribution of prey has not been studied extensively. Udo and Akpan (2004) investigated intersexual and spatial heterogeneity in trophic attributes of the sleeper, *Bostrychus africanus* (Eleotridae) in the Aqua Iboe estuary, also in Nigeria. The authors found out that there was variation in the ingestion of food objects by the sexes and that there was significant increase in the feeding intensity by females than by males. Presently very little information is available on the location of potential fishing grounds as related to the availability of preys in the area. This study therefore investigates some aspects of the trophic biology of fresh water fishes in Cross River and to determine the relationship of the prey and distribution of six fish species: *Oreochromis niloticus, Clarias gariepinus, Chrysichthys nigrodigitatus, Heterotis niloticus, Cyprinus carpio* and *Alestes macrolepidotus.*

MATERIALS AND METHODS

Study site: The study site is the Cross River, a floodplain river located at the south eastern part of Nigeria (Figure 1) on Latitude 4^0, 25´– 7^0.00´N, Longitude 7^0, 15´– 90.30´E. It is bounded in the south by the Atlantic Ocean, East by the Republic of Cameroun, the Nigerian states of Benue in the North, Ebonyi and Abia in the West and Akwa Ibom; South West. Climate of the study area is defined by dry season and wet season. The wet season (April- October) is characterised by high precipitation (3050 ± 230mm), while the dry season (November-March) is marked by low precipitation (300 ± 23mm). Mean annual temperature ranged from 15.5 ± 7.6ºC (wet season) to 32.6 ± 5.4ºC (dry season). For the purpose of this study three sampling sites were selected along the length of the river, with one site randomly selected in each of the following reaches; upriver, middle river and downriver. Upriver was located 3Km from the river source with rocky, gravel and sandy substratum. The shoreline is covered with savanna grassland and has wood and paper industries located close to the source. The middleriver was 100Km from river source with rocky substratum and shoreline sparsely shaded by forest and savanna grassland. Downriver had a muddy substratum and opens up into the Cross River estuary, with shoreline thickly shaded with rainforest.

Physico- chemical sampling: Physico-chemical parameters were determined once every month for two years (January 2006 -December 2007). Standard methods for the examination of water and waste water (APHA, 1987) were used for all measurements. Monthly rainfall data for the study area was obtained from weather meteorological stations, located in each of the three reaches. Habitat variables; water level and river width were measured in three places in each reach and the average was taken.

Ichthyofaunal sampling: The ichthyofuana of the river was sampled at the same time of physico-chemical sampling in all the reaches from artisanal fishers using variety of fishing gears which included; gill net (22-76mm stretched mesh size), seine net (10mm stretched mesh size) and cast net (10mm stretched mesh). On each occasion sampling was between 09.00 and 12.00am. Fish weights were measured to nearest 0.1g and total length (TL) to nearest 1mm. Genus and species identifications was carried out following Elvira (1987) for the Cyprinids; Erkakan *et al.* (2007) for the Bagrids, Teugels (1982) for the Clariidae; Fischer *et al*. (1987) for the Clupeidae and Mugilidae. To determine the relationship of the prey and fish distribution six of the most abundant and commercially important species (*Oreochromis niloticus, Clarias gariepinus, Chrysichthys nigrodigitatus, Heterotis niloticus, Cyprinus carpio and Alestes macrolepidotus*) were selected based on the high demand of species for downstream industries and the increase in annual landings in the last two decades (Teugels, 1982).

Gut content analysis: Fish samples were transported to the laboratory under ice to minimize post mortem changes. Each specimen was measured for total length (cm) and weight (g) with date, time, and location according to Sagua (1979). Fish samples were preserved in deep freezers at -10ºC. The fish were later dissected, gutted and preserved in 4% formaline for subsequent analysis. Each stomach contents were emptied into a Petri – dish and observed under a binocular microscope. Individual food items were identified to the lowest taxonomic level and the entire content analysed using two methods; frequency of occurrence and percentage composition by number (Ricker, 1975).

Statistical analysis: There exist several indices for expressing the quantitative importance of the different food items in the diet of fish (Hynes, 1950, Nataragan and Jhingram, 1961, Hyslop, 1980). Those used in the present study were: Gut Repletion Index, i.e number of non – empty guts divided by total number of guts examined multiplied by 100. Frequency of occurrence of each food object was obtained by expressing the number of stomach each food item occurred as percentage of total number of stomach. Numerical method, food items were counted directly. Food Richness; number of each individual food item in the diet. Diet Breadth; a measure of the food spectrum as determined by Simpsons diversity index and Diet Similarity Index (Simpsons, 1959). Variation in the indices of feeding intensity and diet composition were determined by applying t-test, d-statistics and Spearman rank correlation to the recorded values.

RESULTS

Physico-chemical properties: Water level was highest (47.9m) in the Lower reach and lowest (8.9m) in the Upper reach (Table 1) and was positively correlated ($r = 0.885$, 10df, $p< 0.05$,) with rainfall. River was widest downstream (360.5) and narrowest (102.6m) upstream. Flow rate fluctuated greatly between sampling sites. It was swiftest (0.28 ± 0.17 m/s) upriver and reduced significantly ($p< 0.05$) as it flows downwards. Table 2 shows that among all the physico-chemical parameters measured, temperature values were significantly different between reaches ($P < 0.05$) with higher values in Upper reach (27.3^{0}C) than lower reach (24.1^{0}C). Variation in the transparrency, dissolved oxygen and pH values between reaches were not significant ($p>0.05$)

Fish species: 14,837 fish specimen belonging 47 species, 28 genera and 16 families were examined for their trophic biology. The size range varied between 10 (P*rotopterus annectens*) and 265 (*Oreochromis niloticus*).

The length varied from 2.8 cm (*Pellonula vorax*) to 60.4 cm (*Erpetoichthys calabaricus*).

Diet composition and food indices: The trophic spectra of the 47 fish species is illustrated in Table 3. Eighteen major food objects, classified into 11 primary groups were ingested. The major food objects and their frequency of occurrence in the 47 fish species examined include; detritus (79.9%) , fish and fish fry (41.3%), insect and insect larva (41.3%), phytoplankton (26.1%), crustaceans(23.9%) , mollusk (13%) , macrophytes parts (13 %), seeds (10.9%), worms (0.04%), arachnids (0.02%) and amphibians (0.02%).

Analysis of food objects in the different fish families showed that cichlids and cyprinids fed largely on phytoplanktons (67%), bagrid and clariid catfishes had their diet dominated by fish fry and fish parts (58%) detritus were major food objects in the diet of schilbeids, and mormyrids, (62 %) while dominant items in clupeids, Osteoglassidae, Mochokidae and Distichodontidae were insects (57%).

Food Richness (N) varied from 5 (*Erpetoichthys calabaricus* and *Odaxothrissa mento*) to 20 (*Clarias anguillaris* and *Chrysichthys nigrodigitatus*), Diet Breadth (D) from 0.22 (*Schilbe micropogon)* to 0.88 (*C. anguillaris*) and Gut repletion index (GRI) between 34% (*E. calabaricus*) and 100% (*O. niloticus, Tilapia guinensis, C. anguillaris, C. cameronensis, Heterobranchus longifilis, C. nigroditatus* and *C. auratus*).

Distribution of major food items: Distribution of the four selected fish species and their prey indicated that these fish were predominantly located in a few specific areas (Table 4). *Nymphaea* and *spirogyra* are the main diet of *O. niloticus* and it was found that these food items were distributed in reaches II and I, respectively with a percentage occurrence of between 0.1-10.0% for spirogyra and 0.1-20.0% for nymphaea. Meanwhile, for *H. niloticus*, Reach I and II had the highest abundance of *spirogyra* and *nymphaea* respectively with the percent abundance of 0.1-20.0% for *spyrogyra* and 0.1- 10.0% for Nymphaea. *Pellonula* sp and detritus were the main diet of *C. gariepinus* and the abundance of this diet was higher in Reach I and III respectively. *C. nigrodigitatus* consumed mainly *Macrobrachium* sp and *Nertina* sp distributed predominantlyin Reach II and III respectively.

Based on the distribution of each fish species (Table 5), Lower reach (III) appeared to be the most productive reach while Upper reach (I) was least productive. However, catch rate of *Clarias gariepinus* was highest in the Upper reach.

Table 6 shows the composite array of food objects in the three reaches. Besides the similarity in the food objects in the reaches (r_s= 0.996, p> 0.004), the composition of some of them were not the same. *Macrobrachium* and *Nertina* sp were not encountered in the stomach of the main fish species analysed from the river stretch in savanna area (reach I) while complete array of main food objects were encountered in the river stretch in the forest areas (reaches II and III).

There was seasonal variation in the consumption of food item by fish species (Table 7). Despite similarity of the food objects between seasons, the ingestion of the food items varied significantly (r_s= 0.234, p< 0.05). *Nertina* and *pellonula* sp were not encountered from dry season fish samples whereas the complete array was recorded in the wet season fish samples.

DISCUSSION

Marked variations in the physico-chemical parameters of water observed at the three sampling stations indicate different environmental conditions. Variation in amount and duration of rainfall had been found (Egborge, 1994) to affect physico-chemical parameters which in turn affects fish growth and production (Adebisi, 1981). Generally, rainfall values are highest at the lower reaches and lowest in the upper portion of the Cross River. Low temperatures recorded in the three locations during the rains may be associated with thicker cloud cover, Egborge (1994), in a similar study found to have a reducing effect on solar radiation and concentration of suspended particles which absorbs and scatter heat rays. Higher temperature values in the upper reach may be as a result of lower rainfall in the region. The range of water temperature during the study period was within limits of 25-30^{0}C recorded for tropical rivers (Adebisi, 1981). Secchi disc trasparrency of the three sites were within the range considered suitable for fish growth. Low transparrency observed in the sites during the rains could be caused by influx from runoff into the river which decreased light penetration. According to Boyd (1979) the pH values, 5.5-9.0 is survival range for fishes. The high concentration of dissolved oxygen was satisfactory for fish production. Low organic enrichment of a river had been suggested (Mason, 1992) as the possible reason responsible for such high oxygen values. Seasonal variation observed in dissolved oxygen content with higher values during the rains could be due to lower water temperature and increased aeration.

There was variation in the consumption of the food objects by the different fish species. Despite similarity in the rank- order of some food objects in the species, the ingestion of the food objects varied significantly (r_s = 0.68, p<0.05).

The wider food spectrum exhibited by *C. anguillaris* (D = 0.88), *C. nigrodigitatus* (0.86), *Synodontis amias* (0.77) and *O. niloticus* (0.76) revealed trophic flexibility (Wooton 1979). The ecological advantage of this is that it enables a fish to switch from one category of food to another in response to fluctuation in their abundance. Another advantage is the ability of the species to utilize many different food objects effectively. Fryer and Iles (1972) and Jobbling (1981) listed ; age, size of fish, sex, season, water temperature, habitat and competition as some of the factors responsible to changes in the feeding habit of fish. Morphological changes in the feeding apparatus of the fish as a result of age may also lead to change in feeding habit (Wooton, 1979).

The Gut Repletion Index of 100% (high proportion of the non-empty stomach) among some species (*O. niloticus* , *T . guinensis* , *C. angullaris* , *C. cameronensis, H. longifilis, C. nigrodigitatus* , *C. auratus,* showed that the species are frequent feeders and have higher energy requirement to sustain this level of feeding intensity (King *et al*, 1991). This probably accounts for their higher abundance in the study area. Also the uniformity in the Gut Repletion Index (100%) recorded for these species seem to be a strategy that culminated in their comparative growth rates and the same breeding season for these species. High feeding intensity was also observed in *Mormyrus tapirus (*80%), *T. mariae* (92%), *H. nilocus* (77%) and *Labeo cubie* (88%). Others like; *E. calabaricus* (34), *Protoperus annectens* (38%) *Petrocephalus bovei* (40%) and *Hydrocynus vittatus* (44%) exhibited low feeding intensity which may be responsible for the low abundance of these species in the area. The species related divergence in feeding intensity among the freshwater fishes reduces interspecific competition for food resources and this is seen to sustain large population of the fish species in the Cross River inland wetlands (King *et al*, 1991 and Akpan, 1994). The present information is in unison with reports of heterogeneity in the trophic biology of the estuarine fishes in Imo estuary (King and Udo, 1997).

Observations in this study that cichlids fed mostly on plankton, higher plants and detritus agree with findings by Brown and Colgan (1984) who classified members of this family as plankton feeder, higher plants and algae feeders or macrophagous as well as mud suckers. The piscivorous feeding habit observed in *Hepsetus odoe* during this study had also been recorded by Corbet (1961), Imevbore and Bakere (1970) , Lewis (1974) , Petri (1967), Lauzanne (1975) and Adebisi (1981). They observed that *H.odoe* increased its predatory teething intensity during the low water level, resulting in concentration of the fish species which also accounts for its better condition during the dry season. The high preference shown by *Heterotis niloticus* to phytoplanktons and detritus is in line with the report by Reed *et al* (1967) but disagrees with observation by Bard *et al* (1976) in River Kaduna where the same species do not feed on detritus. High frequency of occurrence of plant grains in the diet of *H.niloticus* is associated with the prefered habitat in grassy areas especially during breeding season as they make their nest on grasses (Bard *et al*, 1976). The fact that detritus dominated the gut contents (79%) of the freshwater species in the study area implied that most of the fish species in the Cross River inland wetlands are detritivores.

In this survey, reaches in river stretch in forest area (middle and lower reaches) appeared to be most productive regions in the study area as compared to savanna (upper reach). These results highlight the importance of vegetation in the productivity of Cross River because it provides great diversity of food items and offers better living conditions.

Conclusion: Most of the freshwater fishes in Cross River inland wetlands are detritivores. The species-dependent regime in trophic spectra showed that there was variation in the consumption of food items by different species despite similarity in the food objects. Further research on the effect of climatic conditions along the length of Cross River on the diet composition of freshwater fishes in Cross River is advocated.

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Table 1: Environmental parameters of each zone surveyed in Cross River (Mean ± SD)

Reach	Current (m/s)	Rainfall (cm)	Water level (m)	Vegetation	Substrate
Upper river	0.93	102.8±74.1	8.9±1.98	Savanna	Sandy Middle
River	0.55	254.9±141.6	16.5±4.21	Savanna/forest	Rocky & sandy
Lower river	0.24	264.3±51.1	47.9±4.9	Forest canopy	Clayey & Rocky

Table 2 Environmental parameters of Cross River (Mean ± SD)

	Reaches Surface Temperature °C	Transparency (cm)	Dissolved oxygen Hydrogen ion $Mg1^{-1}$	Concentration (pH)
Upper river	27.4±1.5	42.1±22.9	6.6±0.8	6.6±0.9
Middle river	26.0±1.4	37.2±19.5	6.8±0.9	7.2±0.7
Lower river	24.1±1.4	33.7±14.3	7.7±0.8	7.0±0.7

Table 3. Diet composition and food indices of 46 fish species in Cross River Inland Wetlands.

Fish families and species	*Sample size* N	*Standard Length (cm)* Min.	Max	*Major Diet Composition*	*Food Richness* (*N*)	*Diet Breadth* (*D*)	Gut Repletion Index (GRI)
Cichlidae							
Oreochromis niloticus	65	12.4	35.6	Spyrogyra (42), Nymphaea (31),& detritus (23).	18	0.76	100
Tilapia guineensis	48	13.9	26.7	Oscillatoria (38), Nymphaea (32) & Detritus (25)	10	0.51	100
Tilapia mariae	27	14.8	24.8	Scenedesmus (37), Pistia (30), Nymphaea (20)	8	0.58	92
Tilapia zillii	20	12.6	22.4	Spyrogyra (40), Azolla (35), Eichhornia (15)	21	0.62	72
Sarotherodon galilaeus	16	13.9	28.4	Nymphaea (43), Lemna(25) & Detritus(12)	8	0.68	83
Hemichromis fasciatus	11	9.4	12.2	Fish fry(35),insects (24),Detritus(20).	6	0.48	51
Hemichromis bimaculatus	13	8.2	13.3	Spyrogyra (38), Fish parts (20), Detritus (17).	8	0.45	68
Protopteriade							
Protopterus annectens	10	21.6	43.5	Mollusc (40), fish fry (21) & seeds (18).	7	0.35	38
Polypteridae							
Polypterus senegalus	21	20.5	51.7	Fish fry (39), inects (22) & frogs (5)	8	0.55	46
Erpetoichthys calabaricus	36	31.4	60.4	Prawns (30), detritus (23),& insects (13).	5	0.31	34
Denticeptidae							
Denticeps clupeoides	42	4.5	12.8	Fish fry (40), Crustaceans (30), Detritus (14)	6	0.42	66
Clupeidae							
Odaxothrissa mento	30	3.8	8.8	Insects (37), algae (23) & annelid worms (8)	5	0.51	72
Pellonula vorax	56	2.8	6.5	Fish fry (34) insect larva (23) & detritus (20)	7	0.58	64
Arpaimidae							
Heterotis niloticus	24	18.8	40.2	Spyrogyra (34), Detritus (28), Nymphaea (22).	11	0.72	77
Mormyridae							
Mormyrus rume	18	18.3	36.7	Nymphaea (32), Detritus (23) & Scenedesmus	8	0.44	78
Mormyrus tapirus	14	15.5	33.3	Detritus (43),Insect larva (20), seeds (10)	8	0.46	80
Mormyrops anguilloides	12	18.3	35.6	Detritus (40), Fish fry (22) & Insects (12).	10	0.58	66
Petrocephalus ansorgii	33	1.8	10.8	Crustaceans (50),Detritus (20) insects (18)	7	0.32	52
Petrocephalus bovei	21	2.3	9.9	Insect larva (34), annelid worms (22) & detritus (15)	8	0.38	40
Hepsetidae							
Hepsetus odoe	10	16.5	38.7	Fish parts (48) fish fry (28) Crustaceans (17)	11	0.46	68
Alestidae							
Hydrocynus vittatus	4.3	11.8	28.5	Fish parts (28) Fish fry (19) & insects (12).	6	0.44	42
Brycynus nurse	30	8.4	18.6	Insects (34), Detritus (28) & Annelids (18)	6	0.32	50
Brycynus macrolepidotus	13	9.4	20.3	Fish parts(44), Custaceans (25) & insects (12)	8	0.38	53
Distichodontidae							
Distichodus rostratus	9	4.5	5.4	Insects (26), detritus (20), & annelid worms (10).	10	0.47	52
Clariidae							
Clarias anguillaris	44	15.5	51.6	Fish fry (27), fish parts (22) & detritus (15).	20	0.88	100
Clarias cameronensis	31	9.0	16.2	Fish (30), mollusk (24) & detritus (12).	14	0.72	100
Clarias aboinensis	4	11.6	25.8	Crabs (25), fish parts (20) & fishfry(11)	12	0.62	72
Clarias gariepinus	17	15.7	38.9	Fish fry (32), prawns (24) & detritus(20)	18	0.82	88
Clarias pachynema	12	9.5	18.7	Fish parts (25) mollusk (23) & prawns (15).	12	0.63	70
Heterobranchus longifilis	23	18.5	61.2	Fish fry (26), fish parts (12) & detritus (12)	16	0.78	100
Bagridae							
Bagrus docmak	4	15.8	32.4	Fish fry (30), fish parts (20) & detritus (19).	8	0.61	58
Claroteidae							
Chrysichthys nigrodigitatus	57	22.3	48.3	Fish fry (35), crustaceans (25) & seeds(20).	20	0.86	100
Chrysichthys auratus	15	10.3	19.8	Detritus (40), insects (27) & fish fry (10).	14	0.68	92
Auchenoglanis Occidentalis	10	14.4	28.3	Detritus (36), fish fry (27) & insects (18).	10	0.52	62
Parauchenoglanis loennbergi	8	5.1	12.3	Crustaceans (36), detritus (23) & annelid worms (8).	10	0.50	57

Mochokidae							
Synodontis omias	21	5.3	14.8	Arachnids (26), insects (19) & detritus (13).	12	0.77	66
Synodontis schall	18	6.6	18.3	Insects (27), seeds (17) & detritus (12).	8	0.67	71
Synodontis obesus	10	4.6	15.6	Seeds (24), insects (20) & detritus (18).	6	0.51	58
Synodontis robbianus	70	5.5	18.8	Insects (30), detritus (26) & crustaceans (20).	7	0.40	62
Malapteruridae							
Malapterus electricus	5	13.8	21.8	Fish parts (27), arthropods (22) & frog parts (19).	6	0.38	35
Cyprinidae							
Labeo coubie	2	20.5	40.6	Algae (37), insects(28) & detritus (20).	12	0.62	88
Labeo senegalensis	5	18.4	30.8	Algae (28), detritus (23) & grains (16).	10	0.52	72
Labeo parvus	8	15.5	28.5	Algae (28), detritus (19) & insects (15).	11	0.60	70
Schilbeidae							
Schilbe mystus	25	8.8	16.4	Detritus (38), insects (23) & annelid worms (14).	8	0.34	55
Schilbe micropogon	15	5.4	14.6	Detritus (40), insects (29) & fish fry (13).	5	0.22	66

Table 4 Distribution of dominant preys with reaches (in parenthesis).

Fish species	Or	Cl	Ch	He	La	Br
No of fish	220	190	201	118	136	343
Empty stomach	0	-	0	12	171	-
Food items	-	-	-	-	-	-
Crustacea	-	-	-	-	-	-
macrobrachium	-	-	0.1-10.0(II)	-	-	-
Insecta	-	-	-	-	-	-
Dipteran adult	-	-	-	-	0.1-10.0(III)	-
Molluscs	-	-	-	-	-	-
Nertina sp	-	-	0.1-20.0(III)	-	-	-
Fish (prey)	-	-	-	-	-	-
Pellonula sp	-	0.1-20.0 (I)	-	-		-
Plants	-	-	-	-	-	-
Nymphaea	0.1-20.0 (II)	-	-	0.1-20.0(I)	0.1-10.0(II)	-
Spirogyra	0.1-10.0 (I)	-	-	0.1-10.0(II)	-	-
Detritus	-	0.1-10.0 (III)	-	0.1-20.0(I)	-	-

Or: Oreochromis niloticus, Cl: Clarias gariepinus, Chrysichthys nigrodigitatus, Heterotis niloticus.

Table 5 Average catch rate (Kg/h) of selected fishes by reaches. I: Upper reach, II: Middle reach, III: Lower reach

	I	II	III
Oreochromis niloticus	0.8	2.8	2.5
Clarias gariepinus	3.8	1.8	2.5
Chrysichthys nigrodigitatus	0.7	3	4.2
Heterotis niloticus	0.5	1	2.4
Labeo coubie	0.8	1	0.5
Bryocynus nurse	0.4	0.8	1.2

Table 6 Average percentage occurrence of the main preys by reaches

Reach Food item	I	II	III
Macrobrachium sp		18.5± 4.5	17.1± 2.2
Nertina sp		0.6± 0.2	34.2±7.6
Pellonula sp (prey)	20.8 ± 2.5	3.4± 1.2	8.2± 4.3
Nymphaea	2.4± 0.8	20.4	1.2± 0.2
Spirogyra	10.4 ± 2.1	9.8± 0.4	3.5± 0.8
Detritus	3.4± 0.5	6.4± 1.7	30.4±2.0

Table 7 Seasonal variation in the mean percentage occurrence of main food items in the stomach of fish species

Seasons Food item	Wet season	Dry season
Macrobrachium sp	22.8± 4.5	5.4± 1.2
Nertina sp	19.8± 6.7	
Pellonula sp	28.6± 4.4	
Nymphaea	3.9± 0.8	20.8± 6.5
Spirogyra	1.8± 0.5	25.5± 5.8
Detritus	23.6± 4.6	8.9± 2.1

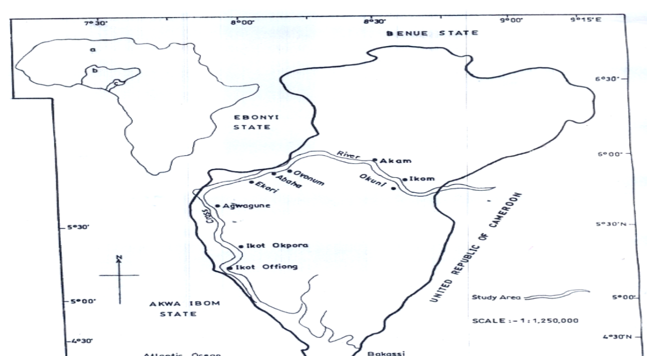

FIG.1: Map of Cross River State showing study area

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