Journal of Natural Sciences Research
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.5, No.2, 2015
www.iiste.org

Analysis of some Aspects of Biology on Selected Fish species in River Hadejia, Jigawa State Nigeria

Azubuike Adams, Rabi S. Duwa, Hadiza Ali Mohd & Chimela Wala
Department of Biological Science Faculty of Science, Nigeria Police Academy,
Wudil, P.M.B 3474, Kano – Nigeria.
Email of the correspondence author:
dr.azubuikeadams@yahoo.com

Abstract
Analysis of some aspect of biology on selected species in River Hadejia, was carried out by analyzing the following, food and feeding habits using two method which are frequency of occurrence and dominant methods, forage to carnivore ratio,(F/C) was also estimated, water analysis was carried out purposely to find the food-fit in the body of water. The forage to carnivore ratio was estimated to be 3:1. while table 1-3 summaries the food items of Tilapia zill Orechromis niloticus and sarotherodon galilaeus. Figure 1, summaries inter and intra specific competition among fish species.
Keywords:- Frequency occurrence, dominant, forage carnivore, food.

1.0 Introduction

Feeding is one of the most important functions of an organism. Other basic function of an organism, which includes growth, development, reproduction, all require adequate nutrition and all these functions take place at the expense of the energy. All the other energy processes within the organism also proceed at the expense of the food. The first stage in the life cycle of a fish is completed at the expense of the food reserves, which it receives from the maternal organism (the yolk in the egg). Fish differ greatly in character of the food they consume. Both the size and systematic position of the food organisms are extremely variable; the range of the food types consumed by fishes is greater than that of other groups of vertebrates (Nikolsky, 1966). Some fishes feed on plants and are termed herbivorous, for example Tilapia spp. Others feed on animals and are termed carnivorous, for example, lates niloticus. Thirdly, some fishes feed on both plants and animals sources and are termed omnivorous, for example clarias spp. They are also the specialized parasitic fishes such as the seas lamprey (Petrolmyzon marinus)

A wide range of kinds and sizes of plants and animals are important in the food chain of fishes. Among the plants are the algae and higher plants. The algae are of many forms, they could be planktonic, others associated with a substrate of some kind of entophytes, epiphytes, or even epizoophytes. Examples of algae includes euglena, volvox and Naicula. Among the earliest animals foods to be consumed by fishes is animals plankton organism zooplankton and these includes different kinds of protozoan, micro crustanceans and other macroscopic vertebrate and the eggs of many insects and animals include those of fishes themselves. No particular food is constantly available to fishes all the year around and this is primarily due to the great changes in the composition of food organism and their availability. Such fluctuation are often cyclic and due to factors of their life histories or to climatic or other environmental conditions for example, insect intend to emerge to a peak level at the onset of rainy season (Lagler, 1977) and so those fishes that feed mainly on insects tend to accomplish most of the annual growth during this season while at the other seasons they feed on the most available food. Olatunde (1978) observed that availability and abundance are the key factors in feeding habits of fishes as most fishes are highly adaptable in what they eat utilizing the most readily available foods.

The more stable the feeding condition of the species, the smaller the range of food to which it is adapted and conversely, the more variable the food supply, the greater the variety of food eaten by the species. Relatively, few fish species are strict herbivores or carnivores and perhaps none at all feed sorely on one organism. Closely related to the variety of food consumed by fishes is the function of the organs for seizing and assimilating the food. The buccal apparatus, which serves for seizing, chewing and swallowing the food, varies in fishes. On this basis, fishes can be classified according to their feeding habit as predators, grazers, food strainers, food sucker and parasites.

Predators usually possess well developed grasping and holding teeth as in the genius Hydrocynus, for example H. brevis and H Vittaus. These group of fishes have a well-defined stomach with strong acid secretions. Gill rakers are shot, few and serves to protect the gill filaments from harm by the food. Grazing fishes that feed on plankton or on botton organism for example, Marmyrus Spp. Straining of organism from water is a generalized type of feeding as the food materials are selected by size and not by kind. Food is taken in along with water that passes into the fill chamber through the mouth. They usually possess gill rankers that are numerous, fine and close-set, for example, Heterotic niloticus, sucking of food into the mouth is often possess protractile mouth, which is equipped with well developed lips forming a sucker ideally suited for feeding on algae and detritue parasitism is perhaps the most in usual feeding habit among fishes. An outstanding example is the parastitic lampreys and hagfishes that suck body fluid from the host fish rasping a hole in the side of the body (Lagler, 1977).

An important factor in feeding is that some species find food by smell and taste and mainly night feeders, for example the family morymyridae which can feed both during the day and night. This is because they have poor sight and so they use electric organ situated on each side of the terminal portion of the tail, which serves as a Rader. Most predators feed largely by sight and are more active during the day light hours. Seasons influence water temperature in the non-tropical areas and water levels in the tropics seem to interfere with feeding in fishes. In the tropics, during the rainly season, the volume of water increases, reducing transparency and concentration of water, which reduces the primary production and all these affect the feeding habits in fishes. Some fishes for example, the lungfish protopeterus annectens during the dry season live for months and accumulated fats (Holden and Read, 1991). Other fishes find and select their food primarily by smell, taste for example Gymnarchus niloticus.

Temperature also determines the rate of feeding, the higher the temperature, the higher the feeding rate and vice-versa, although in the tropics, temperature does not usually alter the feeding rate of fishes as most tropical regions have stable temperature range. Distribution of food is equally important in which when the food materials are distributed in patches, the fish tends to move around in search of food, thereby reducing the feeding rate (Olatunde, 1978). The rate of consumption of food is also connected with the condition of the fish it self, many fishes cease to feed at their spawning time for example O, niloricus which is a mouth brooder.

This work was designed to investigate the stomach content of tilapia species, food fits and forage to carnivore ratio (F/C) in River Hadejia.

2.0 Materials and Methods

2.1 Food and Feeding Habits

The food and feeding habits of the most economically important species were ascertained while establishing the food and feeding interrelationship of the fish in the river. Fish caught in the experimental gill-nets (and others gears including line traps), were kept in deep freezers to reduces post humous digestion. The viscera was opened for each fish and the gut was removed and preserved in 45% formalin. The contents of the stomach were examined within a few hours of being taken to the laboratory. Analysis of stomach contents were done by a combination of frequency of occurrence, dominant (or main content) methods Hynes (1950).

2.2 Frequency of Occurrence Method

The number of stomach sampled in which a given food items is found is expressed as a percentage of all non-empty stomachs examined. It gives an estimate of the proportion of the population that feed on a particular food item. The advantage of this method is its helpfulness in establishing relative abundances. It also requires the less time, and apparatus. It is however inadequate when only a significant component of the diet does not occur in discrete, units of uniform size. It provide little information on the food values of different items.

2.3 The Dominant (or main content) method

The number of food items of a given type that were found in the specimen examined, is expressed as a percentage of all food items. It estimates the relative abundance of that food item in the diet. The major disadvantage of this method is that it provides little information on the food values of the different items in the diet.

2.4 Forage to Carnivore Ratio (F/C)

Based on food type, fish specimen were classified into either forage (F) or carnivore © species.

The ratio of the total weight of the forage (in kg) to the total weight of the carnivorous species (in kg) (F/C) was estimated.

2.5 Water Analysis (For Food-Fit")

A tabular water sampler was used in combination with plankton net to sample the water. The sampler was lowered to pre-selected depths for composite plankton collection.

Food items and other materials entered the sampler through the opening at its base and a messenger was dropped through a connecting cable to trip and dragged over a distance over 100 meters at different depths.

Samples from the nets were empties into labeled sample bottles containing 5% formaldehyde to fix the samples. Specimen were carried to the laboratory for examination using hand lends. Microscopic items were viewed under the microscope. Planktons were counted using Sedquick-Rafter counting chamber. Food items were classified as:

i. Planktons (made up of phyto and zooplantons)

ii. Micro invertebrates (copepods and cladocerans)

iii. Macro invertebrates (made up of insects)

2.6 Food Fit

The total fit (F_f) was determined using the method of Brummett, (1996). This was employed to indicate the average absolute value of the different between the available food and the food consumed by the fish.

3.0 Result

Table I: Summary of food items of Tilapia zilli, in river Hadejia

	Fingerlings		Juveniles		Adults	
Examined	100		80.0			
Content of stomach with food	62		64			
Food items	%FO	%DC	%FO	%DC	%FO	%DC
Plant Materials						
Seeds						
Leaves/Tissues						
Offal						
Phy-Planktons						
Blue green algae	6.45		25.93	6.55	34.38	10.30*
Green algae	11.29	2.20	35.19	12.57*	48.28	14.15*
Diatoms	29.03	15.96*	18.52	5.24	17.24	2.00
Zoo – Plamkton						
Copepoda	33.87	14.64*	38.89	14.52*	24.14	3.50
Cladoceran	29.03	14.04*	37.04	13.43*	31.03	10.70*
Insect						
Chironomid larve	32.26	16.66*				
Chironomid pupae	35.48	20.54*				
Ephemeropteran	-		-		-	
Odonata	-		-		8.62	1.15
Orthopteran	-		-			
Hemipteran	-		-			
Remains of insect	-		29.63	8.45	17.24	1.85
Gastropods/Bivalves	3.23	2.15				

Vertebrates Fish	-		-			
Fish remains	-		-			
Scales	3.23	2.45	51.85	21.48*	68.97	25.08*
Bottom deposits	16.13	8.96	46.30	14.26*	31.03	11.22*
Identified materials	3.23	2.40	18.52	2.10		

FO = Frequency of occurrence
DC = Dominant (main) content
* = Most Prominent food items

3.1 Tilapia zilli

Fingerlings of this species fed mostly on diatoms (15.96%) zooplankton (28.68%) and benthic insects (27.20%). The major food of the juveniles comprised of phytoplankton (green algae 12.57%), zoo-planton (27.95%), scales (21.48%) and bottom deposits.
In the adults, the most dominant food items was fish scales (25.05%) and zooplankton (14.20%) in that order.

3.2 Orechromis niloticus

Out of a hundred specimens each of both juvenile and adults of this species examined 30% and 40% respectively had no food in the stomachs.

Table 2: Summary of food items of Orechromis niloticus, in river Hadejia

	Fingerlings		Juveniles		Adults	
Examined			100		100	
Content of stomach with food			70		60	
Food items	%FO	%DC	%FO	%DC	%FO	%DC
Plant Materials						
Seeds			10.00	0.30	16.67	1.15
Leaves/Tissues			-		-	
Offal			-		-	
Phy-Planktons						
Blue green algae			67.14	20.54*	98.33	68.60*
Green algae			84.29	60.46*	66.67	15.21*
Diatoms			30.00	0.85	33.33	2.18
Zoo – Plamkton						
Copepoda			57.14	5.70	40.00	3.40

Cladoceran			64.29	6.33	66.7	5.79
Insect						
Chironomid larve			21.43	2.67	8.33	0.70
Chironomid pupae			24.29	2.81		
Ephemeropteran			-		-	
Odonata			-		-	
Orthopteran			-		-	
Hemipteran			-		-	
Remains of insect			33.33	2.54	7.27	0.80
Gastropods/Bivalves	-					
Vertebrates Fish	-		-			
Fish remains			-		-	
Scales			14.29	0.34	26.67	1.82
Bottom deposits					16.67	1.15
Identified materials						

FO = Frequency of occurrence
DC = Dominant (main) content
* = Most Prominent food items

Table 3: Summary of food items of Sarotherodon galilaeus, in Rivr Hadejia

	Fingerlings		Juveniles		Adults	
Examined			100		100	
Content of stomach with food	62		60		55	
Food items	%FO	%DC	%FO	%DC	%FO	%DC
Plant Materials						
Seeds			15.00	0.20	27.27	0.50
Leaves/Tissues			33.33	2.0	32.73	1.42
Offal			6.67			
Phy-Planktons						
Blue green algae			90.00	63.00*	92.73	70.12*

Green algae		31.67	22.15*	76.36	16.50*
Diatoms		50.00	4.85	18.18	0.50
Zoo – Plamkton					
Copepoda		39.00	0.91	18.18	0.20
Cladoceran		31.67	1.10	27.27	
Insect					
Chironomid larve		31.67	1.90	27.27	0.58
Chironomid pupae		24.29	0.70	30.19	1.89
Ephemeropteran		-		-	
Odonata		-		-	
Orthopteran		-		-	
Hemipteran		-		-	
Remains of insect		33.33	2.54	7.27	0.80
Gastropods/Bivalves	-	-		3.64	0.50
Vertebrates Fish	-	-			
Fish remains		-		-	
Scales		25.00	0.45	32.73	2.11
Bottom deposits		16.67	0.20	54.55	4.88
Identified materials		-		-	

FO = Frequency of occurrence
DC = Dominant (main) content
* = Most Prominent food items

3.3 Sarotherodon galilaeus

Sixty percent of the assessed juveniles of this species had food while fifty five percent of the adult had food item in their stomachs. This species and the preceding species had similar food components. The only differences is that Blue-green algae dominated the food in both the adults and juveniles of this species unlike the proceeding species where blue green algae dominated in the juveniles. In the species Blue green algae formed 63% and 70.12% of the food items in juveniles and the adult respectively. So its food could be said to be predominatly phytoplankton.

3.4 Forage to Carnivore Ratio (F/C Ratios)

Based on the feeding interrelationship exhibited among the species in river Hadejja, the forage to carnivore ratio was estimated to be 3:1. Table 4.

Table 4: Fish trophic levels and forage to carnivore (F/C) ratio in experimental gill-net and artisanal catches in River Hadejia.

A Primary Consumers

Experimental catches		Artisanal catches	
Species	Wt(g)	Species	(kg)
Brycinus nurse	30766.0	Alestes spp	36.99
Tilapia-zill	64869.0	Tilapia spp	1935.77
Oreochromis nilotius	42862.55		
Sarotherodon galilaeus	76674.85		
	215172.40		1972.7
B Secondary Consumers			
Marcusenius senegalensis	4487.50	Marcusenuis spp	12.02
Brachsinodontis nigrita	3761.40	Synodontis spp	38.36
Siluranodon auritius	10903.00		
	19151.90		50.38
C Tertiary Consumers			
Protopterus annectens	14500.00	Protopetenus sp	19.43
Clarias gariepinus	40539.10	Clarias sp	1170.85
Schilbe intemedius	18016.50		
	73055.60		1506.41
forage to carnivore ratio (F/C) =			
	234325.3 ÷ 73955.60	2023.4 ÷ 1506.41	
	= 3.21:=3:1	= 1.34:1 = 1:1	

Table 5: Summary of Food fit in River Hadejia

Source	Plankton	Micro Invertebrate	Macro Invertebrate	Fish	Plants	(F_r)
River Hadejia	0.78	0.16	0.03	0.02	0.01	
Protepeterus annectens	0.005	0.008	0.009	0.32	0.42	0.060
Marcusenius Senegalensis	0.03	0.25	0.33	0.06	0.21	0.03
Brycinus nurse	0.08	0.24	0.08	0.0	0.57	0.008
Schilbe intermedius	0.01	0.20	0.31	0.36	0.00	0.030
Sihuranodon auritius	0.02	0.06	0.89	0.00	0.01	0.005
Clarias gariepinus	0.06	0.05	0.27	0.35	0.02	0.063
Brachisynodonis nigrita	0.12	0.00	0.2	0.00	0.19	0.12
Tilapia zillii	0.26	0.14	0.23	0.25	0.0	0.030
Oreochromis niloticus	0.85	0.09	0.01	0.02	0.01	0.005
Sarotherodon galilaeus	0.87	0.002	0.03	0.02	0.02	0.015

Note: Food fit (Fr) is an indication of the average of the absolute value of the difference between the food available and the food consumed for each food group by a species of fish (P>0.05 = insignificant).

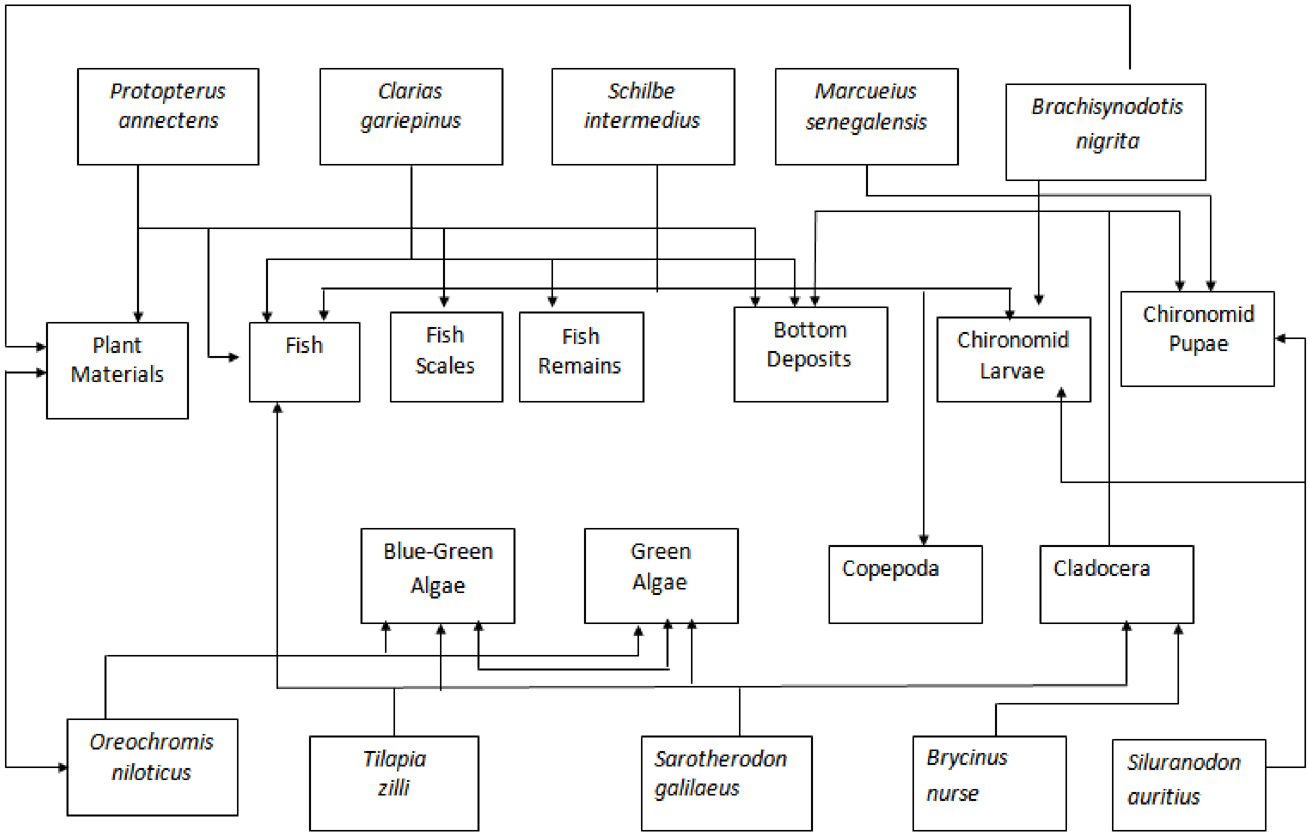

Fig 1: Food web showing inter and intraspecific competition among adult fish species in River Hadejia

4.0 Discussion and conclusion

Tilapia zilli in River Hadejia also fed on assorted food items. It could be said to be closer to omnivore than a herbivore. The fingerlings depended more on phytoplankton, zooplankton and benthic invertebrates in almost equal proportions. The same is true for the juveniles except that the proportion of scales and bottom deposits in its food had increased more than in the fingerlings and the same in true for the adult. In general the food items for both the fingerlings, juveniles and adults over lap. Lewis (1974) reported insects and plants materials as its food. The presence of fish scales in the diet of this species is not uncommon to tilapia. Fryer et al (1955) observed that some cichlids are known to feed entirely on fish scales. It could be that it is an important part of the diet of this species here. However, it could be suggested that since bottom deposits formed part of the food items of the species, the scale could have been ingested with remains of fish at the bottom of the lake. Otherwise, it could be the scale of small fish ingested by them while under paraental care. Oni et al, (1983) reported the species to feed on insect larvae and coarse plant materials.

Furthermore, Fagade and Olaniyan (1973) found that Tilapia melanotheron and T. guineensis had algal filaments, diatoms and organic matter as their principal food items. Fragments of higher plants, and insect appendages were minor components.

Oreochromis niloticus and Sarotherodon galilaeus share common food items in Lake Alau even with the preceeding species. Generally speaking both intraspecific and interspecific competitions were apparently demonstrated by the Alau fish species. For example, the juveniles and adults of both Oreochromis niloticus and Sarotherodon galilaeus complete in their food choice. The juveniles of both species fed predominantly on phytoplankton in an intraspecific competition. Also the fingerlings of Tzilli fed on copepods and chironomid larvae. The juveniles fed on copepods and cladocerans while the adults fed on cladoceran and chironomid puapae. The juveniles of O. niloticus fed on blue green algae and green algae. The adults fed on the same items though in different proportions. It was the same for the juveniles and adults of S. galilaeus.

Fig 1: shows a simple illustration of the inter and intraspecific competition demonstrated by the River Hadejia fish species. Fagade and Olaniyan (1973) showed that such intraspecific competitions existed between clupeid species Sardinella maderensis and Ethmalosa fimbraiata.

Furthermore, most of the species from River Hadejia had chironomid larvae and pupae featuring in their diets. Pennak (1978) made a similar observation that Chironomid form an important food item in the food of young and adult fishes and that without this group of invertebrates many good fishing lakes might be relatively barren.

Zooplankton also forms another major food of the River Hadejia species. Lammens, (1986) found that bream (Abramis brama L) depended on zooplankton in the open waters. He buttressed the importance of chironomid too and stated that breams depended on it in the inshore waters. Cases of empty stomachs recorded among the various species could be attributed to the long hours the fish spent in the gill nets before being removed for examination. Munro (1967) made a similar observation on Tilapia melanoplenra in Lake Mcllwane in East Africa. Holden, (1970) also suggested that the stomach contents might have been vomited after capture.

Most of the fishes were caught during the high water period between July and August of every year. This could be attributed to the fact that the advent of the flood carried with it numerous fish from the marshes and the flood plain along the drainage basins of the river. The cause in the riverine situation is however opposite to this. Fish becomes more difficult to catch in rivers because of flooding. Ita, (1982) made similar observation on Tiga Lake in Kano, Kariba Lake in East Africa. And Volta Lake in Ghana. He reported that good fishing months corresponded to the rainy months in the northern part of the Lake when the water rose. Mbagwu, (1989) related such higher fish yield at this period to the initially high nutrient loads from flooded vegetation, and also revealed the abundance of fish food (macrozoobenthos) to follow this trend. Hence the abundance of fish at this period in the river could be attributed to the abundance of food as well as the copious breeding activities.

The forage to carnivore ratio is not harmful to the fishery. This could account for why the tilapias could be so well established in the river. There is no threat to the proliferation and the young ones growth. The only problem they have apparently is the intensity of fishing.

The 'food fit' generally obtained for the species ranged from 0005 for Oreochromis niloticus and Sluranodon auritius to 0.120 in Brahcisynodontis nigrita. This indicates that River Hadejia wuld be a veritable culture system for the fish species especially the cichlids and Clarias gariepinus, which are already established as choice culturable species in aquaculture. The variability of River Hadejia could be sustained if pond culture is encouraged and introduced around the River.

This seems feasible because the result shows that the fish species are able to use the food items they consume in the water body optimally. Other studies such as Brummett and Katambalika, (1996) elsewhere in Malawi indicated that the pond (with F_r 0.023) was a better environment than the reservoir with Fr value (0.19). with knowledge of 'food fits' qualitative imbalances between food needs and availability might be used to design necessary inputs. This was demonstrated by Brummett, (1996) who recommended the addition of chopped macrophytes to Tainan pond (with Fr value 0.15) against the Taoyaun reservoir (with F_r 0.05). This improved the availability of this food for Oreochromis niloticus and its food fit (F_r) also improved from 0.15 to 0.09. Sagoe, (1998) also prescribed Hausawa burrow pit with an F_r value of 0.022 in Kano State as the best culture environment for Tilapia species studied compared to other burrow pits having Fr values ranging from 0.23 to 0.031.

Experimental gill nets revealed a uniform distribution of fish on the reservoir, which was attributed to food availability, and effective utilization of the available food resources from the various ecological niches.

Conclusion

The intraspectific and interspecific feeding relationship existing among the fish species in the river were revealed(fig 1). Food was found to be more intense during the warm water. The stomach content of tilapi zilli, orechromis niloticus and sarotherodon galilaeus were analysed using two methods frequency occurrence and dominant methods while the forage to carnivore was estimate to be 3:1 which was not harmful to fishery. Thus, River Hadjia provides very good medium for fish performances.

References

Brummett, R.E and Katabalinka (1996): Protocols for the development of indigenous species; polyculture of indigenous species under Malawian smatholder condition. Aquaculture Res 27:225-227.

Fagade, S. O and Olaniyan, C.I.O (1993): The food and feeding Interrelationships of the fishes in the Lagos Lagoon. J. Fish Biols; 205-207.

Fryer, G et al (1955): Scale eating habits of African cichlid fishes Nature, London, 175 pp 108a-1090.

Holden, M and W. Reed (1991): West Africa Freshwater fish. West Africa Nature Handbook, 3rd Edition, pp 27-29.

Hynes, A. B. N (1950): The food freshwater sticklebacks with a review of methods used in studies of the food of fishes. Journal Amimal Ecology 19:36-40.

Ita, E. O. (1982): Biological Indices of Overfishing in Kainji Lake and the Management Proposal for the Lake fishery Kainji Lake Research Institute Technical Report Series No. 8.

Laglea, K. F (1977): Theology (2nd edition). John Wiley and Sons, New York. Pp 504-506

Lammens, E.H.R.R (1986): Interactions between fishes and the structure of fish communities in Dutch Shallow Entrophic Lakes.

Lewis, D.S.C (1974): An illustrated key to the fishes of Lake Kainji pp 10-13.
Mbagwu, I.G (1989): Preliminary swwey of Macrozoobenthes of Tiga Lake Kano State, Nigeria M.Sc Thesis Dept of Biology Sciences, Bayero University Kano pp 79-83.
Nikolsky, G.C (1966): The Ecology of Fishes, Academic Press, London and New York, PP263 -270.
Munro, J.L (1967): The food of a community of East African Freshwater fishes. J. 2001. 151:3, 398-400.
Olatunde, A.A (1978): The Food and Feeding Habits of Entropius Niloticus (Reppell) in Lake kainji, Nigeria, Hydrobiologic 57:197 – 199.
Oni, S.K, etal (1983): Comparative Physiology of Three Ecologically distinct freshwater fishes. Journal fish Biology 22: pp 105-109.
Pennak, R.W (1978): Freshwater Invertebrates of the United State 2nd Edition. Published by John Wiley and Sons incorporated interscience publications pp 80-83.
Sagoe, O.A (1998): Some aspects of the biology of the fishes in the burrow pits in Kano metropolis, Kano State Nigeria. M.Sc theis, Dept. of Biology Sciences, Bayero University Kano.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Academic conference: http://www.iiste.org/conference/upcoming-conferences-call-for-paper/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar