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Food and Feeding Habits of *Citharinus citharus* from Upper River Benue Yola, Adamawa State

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ABSTRACT: *This research determined the feeding intensity and stomach fullness of Moonfish (Citharinus citharus) of Upper River Benue. Sampling was done twice a month for the period of 3 months. The gut contents were analyzed using frequency of occurrence and numerical methods. The feeding intensity of the fish was determined visually after dissection and categorized. A total of 39 fish; 33 (84.6%) males and 6 (15.4%) females were sampled during the study. Food was not present in all guts of C. citharus. The present study showed that 39.4% of the male species had no food in their stomach, whereas 50% of the female species had empty stomach. It was observed that 18.2% and 16.7% of male and female had full stomachs respectively. This was followed by those with ¾full stomachs with percentage fullness of 15.2 % for male and 33.3% for female. Furthermore, 9.0% (male) and 0% (female) was recorded for ½full and ¼full 18.2% for male and 0% female stomachs respectively. Twelve (12) major items were eaten as food by C. citharus. These ranged from plant to animal materials. C. citharus fed on insect's parts, fish parts, zooplanktons, phytoplanktons, sand, red worms, mud, roots, diatom and unidentified materials. In conclusion, C. citharus from Upper River Benue, Adamawa state fed on wide range of food items from plant to animal materials and can therefore be said to be omnivorous*.

KEY WORDS: *Citharinus citharus, feeding intensity, stomach fullness, frequency of occurrence and Numerical methods*

INTRODUCTION

In Nigeria, freshwater ecosystems such as rivers, streams, natural and man-made reservoirs are known to serve different purposes in industries, homes, power generation and agriculture. They are also blessed with variety of fish resources contributing to the socio-economic development of

the people and Nigeria as a Nation (Oladipo, 2018). Water is an important and essential compound in fish life (Oladipo, 2018). The integrity of fish life is a function of water availability, quantity and quality because without water, they cannot exist (Oladipo, 2018). River Niger, a tropical freshwater ecosystem, and the other freshwater bodies in Nigeria house a well diverse fish fauna that are of economic importance with many species awaiting discovery, description and delination (Iyiola *et al*., 2017, Oladipo *et al.*, 2018).

Moonfish (*Citharinus citharius*) is a freshwater demersal and anadromous fish that is yet to be experimented in pond culture (Omojowo and Ihuahi, 2010). It can reach up to 7kg with maximum length of 58cm. It is a total spawner, common in large rivers, feed on phytoplanktons, detritus and other plant matters. It is a potential aquaculture candidate with unreported good performance in ponds. Moonfish belongs to the family Citharinidae and are found in most habitats but they are particularly abundant in swamp, creeks and lakes in Nigeria (Omojowo and Ihuahi, 2010); where they spawn during the flood season. Their deep and flattened body earned them the popular name Moonfish (Gupta, 2006). The species is relatively cheap comparatively but a highly nutritious fish when cooked, smoked or dried. The proximate composition of the moonfish revealed that it contained 77.1% moisture, 0.98% Lipid, 20.4% crude protein and 1.5% ash (Omojowo and Ihuahi, 2010).

The study of food and feeding habits of freshwater fish species is a subject of continuous research. This is because it makes up a basis for the development of a successful management program on fish capture and culture (Shalloof and Khalifa, 2009). Studies on natural feeding of fish enable to identify the tropic relationships present in aquatic ecosystems, identifying feeding composition, structure and stability of food webs in the ecosystem (Otieno *et al.*, 2014). The information is also vital for management of the fish in the controlled environment and for formulation of the appropriate dietery given to the fish in aquaculture (Adeyemi, 2009). Therefore, understanding of its food and feeding behavior is a key factor to its successful culture in a controlled environment (Shalloof and Khalifa,2009).

MATERIALS AND METHODS

Sampling Site

The fish was collected at Upper River Benue, where fishing operation activities are carried out by fisher folks. The research area is located in Yola North local government area of Adamawa state Nigeria. The upper Benue River is the major tributary of Niger River (Jibrin and Shuaibu, 2023). The river is approximately 1400 km long, as result of it, it is an important transportation route in the regions through which it flows (Jibrin and Shuaibu, 2023). It rises in Adamawa plateau of northern Cameroon from where it flows west and through the town of Garoua and lodge reservoir into Nigeria south of the Mandara mountain, and through Jimeta, Ibi and Makurdi, before meeting the Niger at Lokoja. At the point of confluence, the Benue exceed the Niger by volume (mean

discharge before 1960,3400M3/s vs 2500M3/s) during the following decades markedly due to irrigation (Jibrin and Ahuaibu, 2023).

Sampling and Laboratory Experiment
Samples of *Citharinus citharus* were collected from fishermen at the landing site of the river and the experiment was carried out in fisheries laboratory of the Modibbo Adama University, Yola. The sampling was done twice a month for the period of 3 months (from August to October 2023). Fish samples were identified using identification keys (Holden and Reed, 1991). Samples were examined morphologically to see whether they agree with description in the literature before being selected for study. The specimens were sexed and weighed, sexes were examined via handheld microscope and the external genital features were used. Samples were measured for total lengths (TL) and weight were measured to the nearest 0.1cm and 0.1g respectively using a measuring board and weighing scales (sensitive and non-sensitive for those above 300g).
At the laboratory, all tools were thoroughly cleaned and disinfected. The determination of the specimens was carried out as follows:

Fish Sex Identification
The structural sexual dimorphism of the fish specimen was identified through an examination of internal and external sex organs.

Determination of Stomach Content
The state of the stomach was determined visually before dissecting (stomach contents fullness). After the fish sample was dissected, the guts were taken out to remove the stomach. The stomach contents were emptied into petri dish, stomach contents analysis and each food item was counted under objective lens of x 60 magnification power of an electrical binocular microscope. The gut contents were analyzed using frequency of occurrence and numerical methods as described by Hynes (1950), Windell and Bowen (1978) and Hyslop (1980). In the frequency of occurrence method, the occurrence of food items was expressed as the percentage of the total number of stomach containing food, while in numerical method the number of each food item was expressed as the percentage of the total number of food item found in the stomachs. The stomach content analysis was done using a binocular microscope to observe the content in the petri dish. The key to identification guide of food items by Kadiri, (2002) was used to identify the food items.

Analysis of Food/Stomach Contents
The Food of the experimental fish species were analyzed using the following methods reported by Hynes (1950), Windell and Bowen (1978) and Hyslop (1980):

Numerical Method: In the numerical method, data were analyzed by counting the number of each food item present in the stomach of a fish and summed up the numbers to obtain the grand total of all the food items found in its stomach. The number of each food item is then expressed as a percentage of the grand total number of all food items.

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$$\%Ni = Ni \div Nt \times 100$$

Where:
% Ni is the percentage of food item i
Ni is the number of particular food item i
Nt is the total number of food (gut content) items

Frequency of Occurrence Method: In the frequency of occurrence method, the data were analyzed by counting the number of times a particular food item occurs in the stomach and were expressed as a percentage of the total number of stomachs with food (empty stomach were excluded)

$$\%\ \mathrm{Oi} = \mathrm{Ni} \div \mathrm{N} \times 100$$

Where:
% Oi is the frequency of occurrence of given food i
Ni is the number of stomachs containing prey i
N is the total number of stomachs with some food

Feeding Intensity
The state of fullness of each stomach was determined visually based on the distension of the stomachs before dissection, recorded and categorized as:
0/4= Empty stomach
1/4= one quarter full stomach
2/4= half full stomach
3/4= Three quarter full stomach
4/4= full stomach

Data Analysis
The data obtained were analyzed descriptively (means and standard deviation).

RESULTS

Feeding intensity of *Citharinus citharus* from Upper River Benue
A total of 39 fish; 33 (84.6%) males and 6 (15.4%) females were sampled during the study. Food was not present in all guts of *C. citharus*. The feeding intensity of the fish revealed as follows:
0/4= Empty stomach
1/4= one quarter full stomach
2/4= half full stomach
3/4= Three quarter full stomach
4/4= full stomach

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Table 1: Feeding intensity of *Citharinus citharus* from Upper River Benue

Fullness	MALE		FEMALE	
	NO	%	NO	%
0/4	13	39.4	3	50
1/4	6	18.2	0	0
2/4	3	9.0	0	0
3/4	5	15.2	2	33.3
4/4	6	18.2	1	16.7
	33	**84.6**	**6**	**15.4**

Table 2: Stomach Content of C. citharus from Upper River Benue

Table 2 shows the different food materials in the stomach of *Citharinus citharus.*

Table 2. Stomach Content of *Citharinus citharus from* Upper River Benue

Food Materials	MALE		FEMALE	
	%NO	%FO	%NO	%FO
Phytoplanktons	23.5	5.8	23.3	5.3
Zooplanktons	8.6	3.0	4	1.4
Sand	22.6	5.5	23.6	4.7
Root	11.5	3.3	10.7	3.1
Mud	11.21	3.3	16.4	3.9
Plant parts	8.5	2.9	14.1	2.9
Unidentified feed	12.07	3.9	8.1	2.2
Insect parts	5.2	2.9	5	1.6
Fish parts	8.9	2.5	-	-
Diatom	18.3	4.2	-	-
worm	6.7	2.5	-	-
Red worm	2.1	2.1	-	-

Key: NO: Numerical Method and FO: Frequency Method

DISCUSSION

In this study, feeding intensity of fish can be determined based on degree of fullness of stomach Yem *et al.* (2009). The relatively high percentage of almost empty stomach suggests that the

quantity of food was low during the period of this study. Categorization of the stomach of *Citharinus citharus* in the present study showed that 39.4% of the male species had no food in their stomach, whereas 50% of the female species had empty stomach as shown in Table 1, and these agrees with the reports of Malami and Magawata (2010) as well as Abdullahi and Abolude (2001). The few empty stomachs recorded, could probably be due to post harvest digestion while struggling in fishing gears as reported by Ipinjolu *et al*. (2004). According to Vinson and Angrandi (2011), the empty stomachs in fish may be attributed to autecological factors such as variations in gastric evacuation rates, diet, feeding habits, gut clearance rate, presence of non-feeding life stages, as well as individual fish health. Environmental conditions, such as prey encounter rate, temperature, and sampling arti-facts like regurgitated or digested contents upon capture, also play a role. Additionally, species-specific fish behaviour may impact the occurrence of empty stomachs, with certain species being more vulnerable to specific gears when exhibiting increased activity or a higher likelihood of taking baited hooks (Jibrin and Shuaibu, 2023). Frequency of stomach fullness is a key that can be used to determine the feeding intensity of fish in the aquatic environment (Idodo-Umeh, 1987). The high percentage of empty stomach and low percentage of full stomach of *Citharinus citharus* suggests that there was no abundance of food throughout the period of study, this agrees with the findings of Adeyemi *et al*. (2020). The degree of stomach fullness determines the feeding category as well as feeding intensity of fish. Ogbeibu and Ezeunara (2005) did report that ecological conditions governed by seasonal diversity of food could affect the feeding habits, feeding intensity and diets of fish.

Stomach content analysis is a valuable method used in fisheries biology to understand the feeding habits and dietary preferences of fish species. Table 2 shows the different food materials in the stomach content of *Citharinus citharus*. Twelve (12) major items were eaten as food by *Citharinus citharus*. These ranged from plant to animal materials. *Citharinus citharus* fed on insect's parts, fish parts, zooplanktons, phytoplanktons, sand, red worms, mud, root, diatom and unidentified materials. This is in line with the findings of Adeyemi *et al.* (2020), Lawal *et al*. (2010) reported variety of food items eaten by the fish, of which phytoplankton (mainly algae and diatom), crustaceans and molluscs were of primary importance. Atobatele and Ugwumba (2011) did report insect as the dominant prey item followed by crustacean. This observation could be due to difference in plant and animal communities found in the water bodies and available food item found at that particular time. The occurrence of sand/mud, worms, detritus and insect larvae in the food of *Citharinus citharus* could be interpreted as bottom feeders. Similar observation was reported by Adeyemi *et al*. (2020), where the items are abundant in the benthos region of the water body. Ekanem (2003) did report that temporal change in diet composition reflected changes in abundance or number of food organism in the water environment. Physical and chemical composition of the aquatic environment if significantly altered according to Ogbeibu and Ezeunara (2005) which would in turn affect the food and feeding habit of fish species. The high percentage inclusion of unidentified mass in the diet of *Citharinus citharus* could be as a result of post humus digestion of food items from the time of capture to the time of landing of the species. However,

Lagler *et al.* (1977) recorded that time of capture and other factors influence the stomach fullness of any fish.

With respect to the sex ratio, the large number of males with low females recorded in the study could be due to the fact that fishing gears were not set in the breeding grounds. Yem (2009) who had similar result in Kainji Lake posited that the males possibly emigrate from spawning areas towards feeding grounds located in shallow part where they are captured. Burger and Gochfeld (1999) also reported that females could go towards submerged vegetation, and rocky areas to avoid the fishers and protect their offspring.

CONCLUSION

The current research explores the dietary habits of *Citharinus citharus* during the sampled period, revealing a diverse diet that includes phytoplankton, zooplankton, sand, roots, mud, plants part, unidentified parts, insects, fish parts, diatoms, worms. It distinctly characterizes *Citharinus citharus* as a benthic species with insectivorous and detritivorous feeding behaviors, thus suggesting *Citharinus citharus* is primarily omnivorous. Additionally, the research found a higher male population compared to females, with females consistently exhibiting greater foraging intensity.

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