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Food and Feeding Habits of Two Dominant Fish Species in Ureje Reservoir Ado-Ekiti, Ekiti State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Nutrition is one of the key components of living and the study of food and feeding habits of fish species constitute the basis for the development of a successful fish culture and management. This study was designed to investigate the food and feeding habit of two dominant fish species in Ado-Ekiti Reservoir, Ekiti State. The reservoir was demarcated into three zones based on the inputs from its tributaries, the fish samples were collected using fishing gears and chilled with iced blocks from point of collection to the aquaculture unit where each fish sample was identified, biometric measurement was taken, dissected and stomach was examined for the degree of fullness. The stomach content was analysed using frequency of occurrence, numerical and

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volumetric methods. *Sarotherodon galilaeus* and *Coptodon zillii* were found as the two dominant fish species. A total of one hundred and fifty-five samples were collected from the reservoir comprising seventy-three (73) *Sarotherodon galilaeus* and eighty-two (82) *Coptodon zillii* . This gives a male/female ratio of 2:1 and 1:1 respectively. It was observed that a total of 114 (73.55%) out of 155 fish species had food items in their stomachs while the remaining 41 (26.45%) specimens had empty stomach. The diet observed in both fish species are phytoplankton, zooplankton, insects, insect larvae, worms, sand grains and unidentified mass/mud. Volumetrically, phytoplankton was the dominant food item in *S.galileus* (18.49%) and *C. zilli* (28.12%) followed by zooplankton in *S.galileus* (17.15%) and *C. zilli* (20.62%). The results were also similar for the frequency of occurrence and numerical methods except for some minor diet which are worms, insect larvae and sand grains. This suggests that fish species examined are predominantly planktivorous and there is a level of possible competitiveness for food between the two species considering the similarity in their feeding behaviour

Keywords: Diet; planktons; fish; stomach; reservoir.

1. INTRODUCTION

Living organism irrespective of its diversity have to feed not only because they "want to" but because they "have' to" as it is one of the functional attributes of being a living thing. Fishes in general are not excluded from this as they need food like every organism for its nutritional values and benefits for growth, development and other life processes. Nutrition is an essential part of any living organism particularly fish; Feed is known to be one of the most external signals in fish that stimulates its feeding behaviour and growth [1] Like all organisms, fishes require energy to fuel their body machinery and processes, including growth, metabolism and reproduction. Fish feed on a great diversity of food items but in their own peculiarity, they feed on food items such as phytoplankton, zooplankton, benthic and non-benthic invertebrates, benthic deposits, other fish and aquatic macrophytes.

Fish composition and growth pattern are important in understanding the biology of fish population in any water body and it provides valuable information on the diets, lifespan, stock composition and fish production [2] “The diet of cultured fish species does not provide precise and reliable information on the food and feeding habits and condition factor of such species. Hence, most studies which are aimed at obtaining such information are based on the analysis of gut contents of fish caught from their natural habitats” [3]. “The study of the food and feeding habits of fish species is a subject of continuous research because it constitutes the basis for the development of a successful fisheries management programmed on fish capture as well as culture and because the aquatic ecosystem is dynamic. The gut content is a reflection of the water quality, all other factors being constant. The natural habitats offer a great diversity of organisms that are used as food by fish, which differ in sizes (microscopic and macroscopic) and taxonomy groups [4]. “The dietary analysis of fish in their natural habitats enhances the understanding of the growth, abundance, productivity and distribution of organisms. Condition factor is used as an index of growth and feeding intensity and decrease with increase in length. It influences the reproductive cycle in fish and it is an important fishery management tool in estimating the relative well–being of a fish population in a particular river system” [5].

“The major factors that can influence feeding behavior of fish, such as stocking density, sex ratio, reproductive status, and biologic rhythms, have been subject to limited investigation and results often conflict between and within species” [6]. “The feeding behavior of fish is complex and has been studied extensively in cultured fish and wild fish from ecological perspectives” (Gerking, [7], Lamb et al., [8]. “Several behavioral responses have been linked to methods of feeding, feeding habits, frequency of feeding, mechanisms of food detection, and food preferences. The food organisms consumed by fish in natural environments may range from algae, plants, and detritus to small prey, such as crustaceans, mollusks, polychaetes, and other fish. It is well recognized that various combinations of sensory systems during the different phases of gustation and feeding are required to achieve desired food consumption; however, the acceptance or rejection of feed is physiologically dependent on inputs from chemoreception” [9].

"The study of the food and feeding habits of fish species is a subject of continuous research. It is an important biological factor for selecting a group of fish for culture in ponds to avoid competition for food among themselves; live in association and to utilize all the available food. Food and feeding habits of fish constitute the basis for the development of a successful fisheries management program on fish capture and culture and because the aquatic ecosystem is dynamic, the gut content is a reflection of the water quality, all other factors being constant. It is virtually impossible to gather sufficient information on food and feeding habit of fish in their natural habitat without studying its gut contents. A thorough knowledge on the food and feeding habit of fishes provide keys for the selection of culturable species and the importance of such information is necessary for successful fish farming. Moreover, studies on natural feeding of fish enable to identify the trophic relationships present in aquatic ecosystems, identifying feeding composition, structure and stability of food webs in the ecosystem. The information is also vital for management of the fish in the controlled environment and for formulation of the appropriate diet given for the fish in aquaculture. Without knowledge of the food requirements, feeding behavior pattern, and predator-prey relationships, it is not possible to understand the predicted changes that might result from any natural or anthropogenic intervention" Teugels et al., [5]. Therefore, understanding of its food and feeding behavior is a key factor to its successful culture in a controlled environment.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out at Ado-Ekiti reservoir. The Reservoir is a major source of water supply for domestic uses and also supports artisanal fisheries. The Reservoir lies between latitude 7º – 70º North and longitude 10º – 50º East at an altitude of about 440m above sea level.

2.2 Fish Collection and Sampling Procedures

The reservoir was demarcated into three zones based on the inputs from its tributaries. Specimens of *Sarotherodon galilaeus* and *Coptodon zilli* were collected using fishing gears with the aid of the fishermen operating on the reservoir. Gears employed included gill nets, cast nets, traps, hooks and lines. Samples were chilled in iced blocks at the point of collection before being transported to the Aquaculture unit of the Department of Zoology and Environmental Biology, Ekiti State University Ado-Ekiti, for analysis.

The weight of each specimen was taken using a top loading metler balance to the nearest 0.1 g after draining excess water with a pile of filter paper while the length was measured from the most anterior part of the fish to the tip of the longest caudal fin for *Sarotherodon galilaeus* and *Coptodon zilli.* Standard length was measured in the nearest 0.1 cm using a measuring board. Fish samples were collected during day time when fishes were actively feeding.

2.3 Degree of Fullness of Stomach

The fullness of the stomach was determined by grading the volume of the items in the stomach relatively to the stomach 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.

2.4 Analysis of Stomach

Specimens were dissected and the gut taken out to remove the stomach. Specimens of *Sarotherodon galilaeus* and *Coptodon zillii* with food contents in their stomachs were considered for stomach analysis and their stomachs were preserved in 4% formalin in labelled bottles. In the Laboratory, the number of prey organisms were identified to the lowest possible level. Analysis was done using an index of Relative Importance (IRI) for each prey. This was determined by using the formula;

% Index of Relative Importance (IRI) = % N + %F + %V

Where, % N was the number of individuals for each prey category recorded in all food items expressed as the percentage of the total number recorded for food items, %V was the volume of each food item expressed in percentage. %F was the number of stomachs in which each prey item occurred and expressed as a percentage of the total number of stomachs.

2.5 Numerical Methods

The stomach contents were emptied into a petri dish and food items were sorted out into categories using binocular (x50) microscope. Each category of food items was identified and counted under the microscope.

$$\text{Numerical \%} = \frac{number\ of\ food\ item\ i}{\text{total number of identified food item}} \times 100$$

2.6 Frequency of Occurrence

In the frequency of occurrence method, the individual food items were sorted out and identified. The number of stomachs in which food items occurred was recorded and expressed as a percentage of the total number of the stomach examined. Empty stomachs were not recorded.

$$\text{Frequency of Occurrence} = \frac{\text{total stomach with } food\ item\ i}{\text{total stomach with food item}} \times 100$$

2.7 Percentage Volume

The volume of each food item was determined by knowing the volume of the stomach alone using water displacement method and subtracting it from the volume of stomach with food content. The volume of each food item was then expressed as a percentage.

$$\text{\% Volume} = \frac{Volume\ of\ each\ food\ item}{\text{total volume of identified food item}} \times 100$$

2.8 Data Analysis

Analysis of Variance was used to analysis data collected in this study.

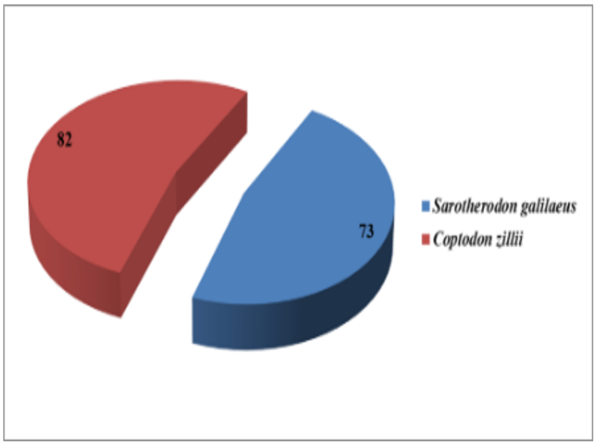
3. RESULTS

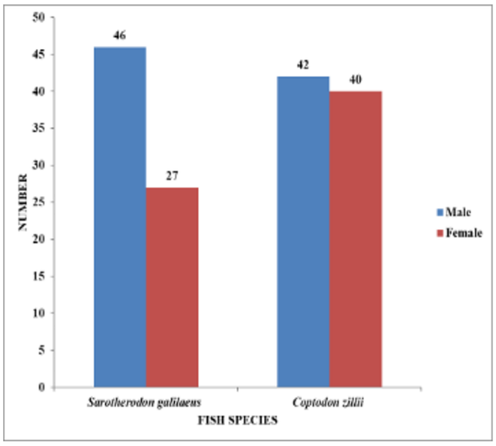
3.1 Fish Species

The two dominant fish species observed in the reservoir are *Sarotherodon galilaeus* and *Coptodon zillii* hence the food and feeding habits of both species were examined. A total of one hundred and fifty-five samples were collected from the reservoir comprising seventy-three (73) *Sarotherodon galilaeus* (46 males and 27 females) and eighty-two (82) *Coptodon zillii* (42 males and 40 females) as illustrated in Fig. 1a and 1b This gives a male/female ratio of 2:1 and 1:1 respectively.

3.2 Biometric Measurements of Two Dominant Fish Species from Ado-Ekiti Reservoir

The body weight of examined fish species from Ado-Ekiti Reservoir ranged from 22.68-216.88g and 46.6-271.50g with a mean± S.D weight of 116.40±56.11 and 176.99±68.19 in the male and female species of *Coptodon zillii* respectively while the body weight of the male and female species of *Sarotherodon galilaeus* ranged from 47.91-509g and 33.45-279.82g with a mean± S.D weight of 194.32±81.34 and 124.37±67.64 respectively. The male *Coptodon zillii* had an average total and standard length of 24.64±4.89 and 22.20±4.25 ranging from 15.5 to 32.1 cm total length (TL) and 13.8 to 29.0 cm standard length (SL) respectively, while the female had an average total and standard length of 21.89±3.56 and 18.62±3.06 ranging from 16.1 to 29.2cm total length (TL) and 13.5 to 27.6cm standard length (SL) respectively. The average total and standard length of *Sarotherodon galilaeus* are 22.55±3.24 and 18.63±3.09 ranging from 16.5 to 33.3 cm total length (TL) and 14.2 to 29.3 cm standard length (SL) in the male while the female had 25.13±5.57 and 22.12±5.03 ranging from 15.5 to 35.2 cm total length (TL) and 12.2 to 31.0 cm standard length (SL) respectively. Table 1 shows the body measurement of fish species examined during the period of the study.





Figs. 1a and 1b*. Showing the abundance and sex ratio of S. galileaus and C. zilli*

Table 1. Body measurement of observed 2 dominant fish species from Ado-Ekiti reservoir

	Sarotherodon galilaeus				***Coptodon zillii***			
	Male		**Female**		**Male**		**Female**	
	Range	**Mean± S.D**	**Range**	**Mean± S.D**	**Range**	**Mean± S.D**	**Range**	**Mean± S.D**
Weight (g)	47.91-509	194.32±81.34	33.45-279.82	124.37±67.64	22.68-216.88	116.40±56.11	46.6-271.50	176.99±68.19
TL (cm)	16.5-33.3	22.55±3.24	15.5-35.2	25.13±5.57	15.5-32.1	24.64±4.89	16.1-29.2	21.89±3.56
SL (cm)	14.2-29.3	18.63±3.09	12.2-31.0	22.12±5.03	13.8-29.0	22.20±4.25	13.5-27.6	18.62±3.06

Table 2. Sexual dimorphism of fish stomach with food items

Parameters	**Number of Stomachs with Food Items**		**Number of Stomachs Without Food Items**	
Fish Species	**Male**	**Female**	**Male**	**Female**
Sarotherodon galilaeus	34	19	12	8
Coptodon zillii	29	32	13	8
Total	**114**		**41**	

Table 3. Degree of fullness of stomach of observed two dominant fish species from Ado-Ekiti Reservoir

		Degree of Stomach Fullness				
		Empty Stomach	**¼ full Stomach**	**½ full Stomach**	**¾ quarter Full Stomach**	**Full Stomach**
Sarotherodon galilaeus	Male	12	13	3	7	11
	Female	8	7	8	3	1
Coptodon zillii	Male	13	10	10	6	3
	Female	8	10	7	8	7
	Total	**41**	**40**	**28**	**24**	**22**

Table 4. Class of food items in the diet of *Sarotherodon galilaeus* and *Coptodon zilli* from Ado-Ekiti Reservoir

Food item	**Numerical Methods (%)**		**Frequency of Occurrence Methods (%)**		**Volumetric Methods (%)**	
	Sarotherodon galilaeus	***Coptodon zillii***	***Sarotherodon galilaeus***	***Coptodon zillii***	***Sarotherodon galilaeus***	***Coptodon zillii***
Phytoplankton	89.65	45.77	100.00	86.89	18.49	28.12
Zooplankton	7.85	21.92	100.00	65.57	17.15	20.62
Worms	2.00	-	9.62	-	7.84	-
Insect	0.30	32.31	1.92	29.51	11.26	3.69
Insect larvae	0.20	-	1.92	-	3.67	-
Sand grain	-	-	100.00	100.00	10.33	26.06
Unidentified mass	-	-	100.00	100.00	31.28	21.51

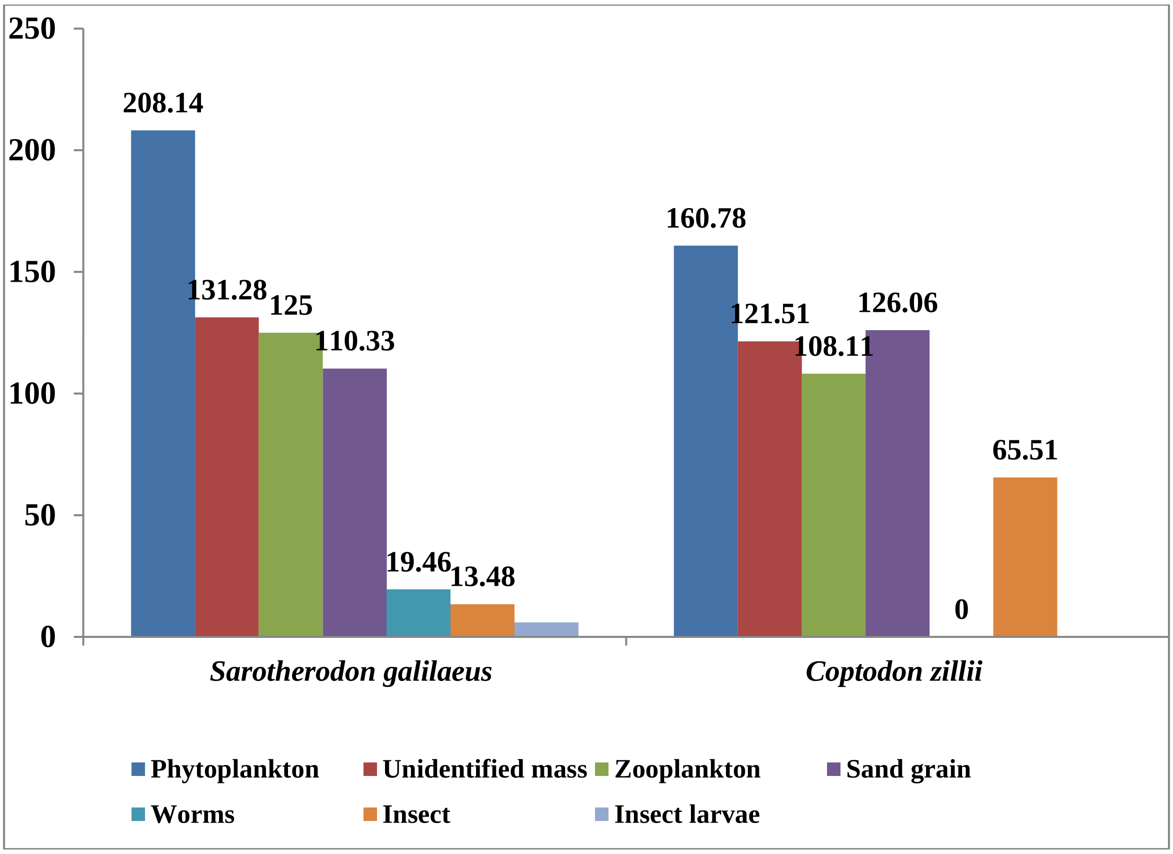


Fig. 2. The index of relative importance (IRI) of the food items in the diet of 2 dominant fish species from Ado-Ekiti Reservoir

3.3 Proportion of Examined Stomach of Two Dominant Fish Species from Ado-Ekiti Reservoir

As shown in Table 2, it was observed that a total of 114 (73.55%) out of 155 fish species had food items in their stomachs while the remaining 41 (26.45%) specimens had empty stomach. In male *Sarotherodon galilaeus* the proportion of stomach with food items was 34 while 12 had empty stomach. In the female 19 had stomach with food content and 8 were without food item. The male *Coptodon zillii* had 29 stomachs with food content while 13 were empty while the female had 32 stomachs with food and 8 empty stomachs.

3.4 Degree of Stomach Fullness of Two Dominant Fish Species from Ado-Ekiti Reservoir

It was also observed from the degree of stomach fullness that the male *Sarotherodon galilaeus* had 13 one quarter full stomach, 3 half full stomach, 7 three quarter full stomach and 11 full stomachs while the female had 7 one quarter full stomach, 8 half full stomach, 3 three quarter full stomach and 1 full stomach. In *Coptodon zillii* the male had 10 one quarter full stomach, 10 half full stomach, 6 three quarter full stomach and 3 full stomachs while the female had 10 one quarter full stomach, 7 half full stomach, 8 three quarter full stomach and 7 full stomachs as shown in Table 3.

3.5 Food and Feeding Habits Observed in Two Dominant Fish Species from Ado-Ekiti Reservoir

The items encountered in the stomach of both species examined include phytoplankton, zooplankton, insects, insect larvae, worms, sand grains and unidentified mass/mud (Table 4). In the diets of *Sarotherodon galilaeus*, it was observed that the Phytoplankton had 89.65% by number, 18.49% by volume and occurred in 100% of the stomach. Zooplankton accounted for 7.85% by number, 17.15% by volume and occurs in 100% of the stomachs. Worms accounted for 2.0% by number, 7.84% by volume and occur in 9.62% of the stomach content. Insect observed from the study had 0.3% by number, 11.26% by volume and occurred in 1.92% of the stomach content. The observed insect larvae during the study had 0.2% by number, 3.67% by volume and occurred in 1.92% of the stomach content. It was also observed that sand grains and unidentified mass/mud were common in the stomach content of the specimen, making up to 10.33% and 31.28% by volume and occurred in 100% of the stomach respectively (Table 4).

The stomachs of *Coptodon zillii* consisted mainly of phytoplankton, zooplankton, insects, insect larvae, worms, sand grains and unidentified mass/mud (Table 4). In the diets, it was observed that the Phytoplankton had 45.77% by number, 28.12% by volume and occurred in 86.89% of the stomach content. Zooplankton accounted for 21.92% by number, 20.62% by volume and occurs in 65.57% of the stomach content. Insect observed from the study had 32.31% by number, 3.69% by volume and occurred in 29.51% of the stomach content. It was also observed that sand grains and unidentified mass/mud were common in the stomach content of the specimen, making up to 26.06% and 21.51% by volume and occurred in 100% of the stomach respectively (Table 4).

3.6 Index of Relative Importance

The IRI indicated that phytoplankton is the most important food items of both species in the dam and constituted 208.14% and 160.78% for *Sarotherodon galilaeus* and *Coptodon zillii* as shown in Fig. 2.

4. DISCUSSION

The major food items of *Sarotherodon galilaeus* and *Coptodon zillii* from Ado-Ekiti Reservoir were found to be similar. They include phytoplankton, zooplankton, insect, sand grains as well as mass of unidentified items. From the study, it was observed that the diet of these two species showed that there was moderate percentage of sand grains in their stomach. This is an indication that the species are bottom grazers. The data obtained in this study indicated how successful these fish population has been in exploiting the available food resources in the reservoir. The stomach content analysis indicated that both *Sarotherodon galilaeus* and *Coptodon zillii* fed on a wide range of food items which is similar to the report of Yem et al., [2] on *Oreochromis niloticus* who feeds widely across different trophic level in Wase dam. Generally, fishes are not rigid regarding the particular type of food they eat and will utilize the most readily available food item.

"The quantity and quality of food item fed on by the fish may also vary with size, age, sex and time of feeding" [10]. "Food types of *Sarotherodon galilaeus* and *Coptodon zillii* were reported to be mainly plant materials such as remains of water hyacinth; *E. crassipes*. The water hyacinth is used as a substrate by epiphytic algae and, as the fish forage on the algae they consume even the substrate itself. Detritus as food type of indicates that the species is a bottom feeder. This finding is in agreement with the findings" [11,12]. "The two fish species exhibited the characteristics of an omnivore in the reservoir. Ecological studies in some reservoirs" Abayomi et al., [13] and ponds have shown that juveniles of *Sarotherodon galilaeus* fed in decreasing order of preference on insects and crustaceans, mollusks, detritus and plankton [14,15]. "*Coptodon zillii* has been observed to possess proteases similar to carnivorous species, starch digestive capabilities similar to those of specialized herbivore and lysozome and alkaline phosphatase as detrivores. *Sarotherodon galilaeus* is physiologically equipped to cope with frequent and irregular meals as its digestive enzymes respond faster than those of eel (*Anguilla anguilla*) or carp (*Cyprinus carpio*) to feeding" [12]. The most frequent food component in this study was the phytoplankton [16,17]. This result agreed with the observation of Adeyemi et al. [12] for *Sarotherodon galilaeus* diets in Asi River and Gbedikere Lake. The food and feeding habit of *Sarotherodon galilaeus* from Olupanna Reservoir was studied and the diet was found to comprise mostly of phytoplankton in fingerling, juvenile and adult stages Adeyemi et al., [12] which in agreement with the result of this study [18].

"The general low numbers of zooplankton in the stomachs of *O. niloticus* could probably be attributed to turbidity of the lake water which reduces visibility of the predators and on feeding rhythms. The lack of clear zoo-plankton species selectivity pattern could be due to importance of other food items. It is important to emphasize that the effect of seasonality should always be considered in the studies on natural feeding of fish, because the temporal changes of biotic and abiotic factors alter the structure of the food web along the year and as a consequence, the fish often shows seasonal diet shifts" [13,19,20].

5. CONCLUSION

This study showed that both fish species are omnivores who feeds mostly on planktons and due to high similarity in the diet of the two species there could be a degree of food competition in the reservoir. This competition makes them to occupy the same ecological niche within the dam. For both species, the percentages of empty stomachs were rather modest and did not significantly differ from one another. This observation suggests that these fish species have access to food, although not in large variety. One could argue that there were not many natural foods in the dam.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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