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Morphological Charactirization of Fish Fins and Predator-Prey Dynamics among Selected Fish Species in Kwatan Giwa River, Niger State, Nigeria

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Abstract

This study investigates the influence of fin morphology on predator-prey dynamics among selected fish species in Kwatan Giwa River, Niger State, Nigeria. A total of 192 fish samples representing eight species were collected biweekly from June to August 2024 at the Kwatan Giwa River fish landing site. Fish species were identified using standard taxonomic guides. Morphometric measurements of tail, pectoral, dorsal, and ventral fins were recorded using vernier calipers. Gut content analysis was conducted following modified Waraniak *et al*., (2019) procedures to determine dietary components and establish trophic relationships. Data were statistically analyzed to assess variations in fin structures and their ecological implications. The findings revealed significant interspecific variations in fin morphology. Species like *Tilapia zilli* and *Auchenoglanis biscutatus* possessed higher pectoral and ventral fin lengths, facilitating better maneuverability and habitat adaptability. Conversely, *Siluranodon auritus* exhibited consistently low fin measurements, indicating limited mobility and habitat specialization. The gut analysis revealed that *Clarias gariepinus*, identified as a piscivorous predator, had gut contents containing scales and remains of *Tilapia* spp, juvenile *Synodontis, Labeo senegalensis*, and *Marcusenius senegalensis*. In contrast, *Tilapia* spp, *Labeo senegalensis*, *Auchenoglanis biscutatus*, and *Siluranodon auratus* showed no fish remains in their guts, indicating non-piscivorous diets. The study successfully highlighted the relationship between fin size and predation strategies among selected fish species in the study area. However, Efforts should be made to protect the natural habitats of these fish species from degradation due to pollution, deforestation, and human encroachment.

Keywords: Fish Fin Morphology, Predator-Prey Dynamics, Kwatan Giwa River, Fish Locomotion, Fish Survival.

INTRODUCTION

The global fishes comprise more than half of 55,000 species of living vertebrates (Gene *et al.,* 2009). Fisheries management is an important tool for the proper utilization and sustainability of aquatic resources. To achieve this, it often requires using a biometric relationship so that data collected from the field can be transformed into appropriate indices (Ecoutini *et al.,* 2005). Length-weight and predator-prey are two useful parameters used especially in fisheries assessment and management. Length-weight helps to determine the average weight of fish and is widely used in assessment of fish population densities for proper management methods (Nash *et al.,* 2006). Remarkable ecological diversity, different feeding habitats, and all sorts of life in aquatic medium exist. Predator and prey are associated with feeding relations where fish depend on fish, insects, invertebrates, crustaceans, and others creatures. Most animal species are engaged in a predator-prey relationship by consuming prey or falling victim to predators or both. These relationships functionally offers a way to understanding the complexity in that predator–prey communities (Berlow *et al.,* 2009). These Predator-prey relationships are classically viewed as consumptive acts between two species (Goteli, 2008). In aquatic communities, the body size of both prey and predator is one attribute that has been linked directly to foraging success. Predators become more successful with size due to a variety of factors including increased sustained and fast swimming speeds and better visual acuity (Webbi1976, Beamish, 1978). The escape response of prey is also strongly related to body size, reaction distances increase and swimming performance is enhanced with size (Blaxter and Fuiman 1990). The morphology of predators and prey changes with ontogeny as predator gape size increases and morphological defenses of prey (e.g. spines) become more robust. The relation between prey size and predator size has therefore been recognized as being of paramount importance in determining the outcome of interactions among species. Fish fins have been a key feature of fish evolutionary diversification (Lauder and Madden, 2007) and their main function is thought to produce propulsive thrust for swimming. Fish fins are folds of skin supported by skeletal elements controlled by fin musculature and may be used for swimming, reproduction, display or protection (Standen, 2011). Larger fins result in more power being transferred from body muscles into the surrounding fluid (Weihs, i1989). However, Studies on length -weight and predator-prey relationship of selected fish have been done in some water bodies. Literature has shown that pectoral fin swimmers have high optimal swimming speeds (Cannas *et al.*, 2006; Fulton *et al.*, 2013; Korsmeyer *et al*., 2002). Fish body shape, fin shape and kinematics for pectoral fin swimmers correlate with their swimming performance and habitat use (Fulton, 2010; Walker and Westneat, 2002 a,b). Fish fin shape could be summarized by the aspect ratio (AR), which is the ratio between the length of the leading edge and the surface area of the fin (Blake, 2004). Fish with pectoral fin having wing-like, long tapered fins (high fin AR) have lift-based thrust and are faster swimmers and more efficient at prolonged, steady swimming at higher speeds; likewise, fish with paddle-shaped pectoral fins (low AR fin) produce a resistance-based thrust that is more effective for high thrust production at lower speeds and maneuvering (Fulton, 2007). Literature had it that species with high AR pectoral fins are more abundant in highly wave-swept habitats while species with low AR pectoral fins are rare or completely absent in these habitats (Bellwood and Wainwright, 2001).

Knowledge of fish predator-prey relationships helps to understand population dynamics that is crucial for sustainable fishery. Fisheries managers could develop strategies in maintaining healthy fish populations, increase harvesting rates and protect particular water body. This research work has not been documented in the area of study. These selected fish species are among commercially important freshwater fishes found in catches of fishermen in this study area, therefore there is need for their management, conservation and sustainability.

MATERIALS AND METHODS

Location of the Study

The study was conducted at Kwatan Giwa River, Gana Village, Lapai Local, Niger State Nigeria from June -August 2024. Kwatan Giwa River (Latitude $9^0$13N and Longitude $6^0$34E) is tributary of Lapai-Agaie Dam reservoir. It is a small water body with a mean depth of 6.1 meters, constructed for the supply of portable drinking water and irrigation, but the communities are using the advantage as wild fisheries resources.

Fish Sampling and Collection

One hundred and ninety two (192) samples of selected fish species of various sizes were purchased from the fishermen fish landing site fortnightly. The Samples were carefully collected in a cooler containing ice block to maintain freshness and transported to Animal Production Laboratory, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria.

Fish Identification

Upon arrival, the fish were tagged and labeled alphabetically from letter (A-H) with 3 replicate samples. The samples were examined fresh and species identification was done according to description of Reed *et al.*, (1967) and Holden and Reed (1972). Different species of the same genus were also identified.

Fish Fin Length Measurements

Standard length (from the tip of the snout to the caudal peduncle), total length (tip of the snout to the longer part of the caudal fin) of each fish sample were measured to the nearest 0.1 centimeter. The length was measured using measuring board and tape. The caudal, pectoral, dorsal, and ventral fins of each species were carefully measured to the nearest 0.1 centimeter in eight replicates, using vernier caliper and the average for each sample computed. The selected species were labeled A-H and pictures taken from the field.

Gut Content Analysis

Gut content analysis were conducted as described by Waraniak, *et al*., (2019) with some modifications. The stomach contents of fish were examined to determine what they have recently eaten for direct evidence of predator-prey interactions. They were immediately stored in ice water to prevent digestion from altering the gut contents. The digestive tract, usually the stomach/ intestines, was carefully removed under sterile conditions and the gut contents were then sorted under a dissecting microscope. Preyed items (e.g., fish, fish parts like, scales, fins, spines, bone, operculum, etc) were identified to the lowest possible taxonomic level (species, genus, or family) using their preserved samples as guide.

RESULTS

The Selected Fish Species from Fish Kwatan Giwa River

The following eight fishes were identified from the catch at Kwatan Giwa river landing site for the study. They include; *Clarias gariepinus* (North African catfish) labeled as A, B. *Tilapia spp*. (Tilapia) labeled as B, *Labeo senegalensis* (African carp) labeled as C, *Marcusenius senegalensis* (Trunkfish) labeled as D, *Auchenoglanis biscutatus* (Black Spotted catfish) labeled as E, *Malapterus electricus* (Electric catfish) labeled as F, *Synodontis nigriventris* (Upside-down catfish) and *Siluranodon auritus* (Schilbe with ear) as shown in Figure 1 below.

Figure 1: Selected fish species from Kwatan Giwa River. A (*Clarias gariepinus*), B (*Tilapia spp*), C (*Labeo senegalensis*), D (*Marcusenius senegalensis*), E (*Auchenoglanis biscutatus*), F (*Malapterus electricus*), G (*Synodontis nigriventris*) and H (*Siluranodon auratus*)

Table 1: Scientific and Common Names of the Selected Fish Species Collected from Kwatan Giwa River, Gana Village, Lapai Local, Niger State, Nigeria

Identification label	Scientific Names	Common Names
A	*Clarias gariepinus*	North African catfish
B	*Tilapia spp*	Tilapia
C	*Labeo senegalensis*	African carp
D	*Marcusenius senegalensis*	Trunkfish
E	*Auchenoglanis biscutatus*	Black Spotted catfish
F	*Malapterus electricus*	Electric catfish
G	*Synodontis nigriventris*	Upside-down catfish
H	*Siluranodon auratus*	Schilbe with ear

Fin Morphological Properties of Some Selected Fish Species from Kwatan Giwa River

The fin morphological properties of Some Selected Fish species from Kwatan Giwa River is shown in table 2.0. There is statistically significant difference ($p>0.05$) in the TFl=tail fin length, PFL= Pectoral fin length, VFL= Ventral fin length, DFL= Dorsal fin length, DFH=Dorsal fin height. *Siluranodon auratus* and *Marcusenius senegalensis* have lower tail fin length and are statisticay nt significant whie *Malapterus electricus* and *Clarias gariepinus* have high tail fin length but lower than *Labeo senegalensis, Tilapia zilli* and *Auchenoglanis biscutatus. Clarias gariepinus, Labeo senegalensis, Malapterus electricus* and *Siluranodon auratus shows lower* Pectoral fin length and have no statistically significant but *Tilapia zilli* and *Auchenoglanis biscutatus* have higher Pectoral fin length and are statistically significant. All other fishes have lower ventral fin length and are statistical not significant but *Tilapia zilli* has higher ventral fin length. The dorsal fin length of the fish were statistically significant *Siluranodon auritus* and *Labeo senegalensis* have low dorsal fin length, *Clarias gariepinus* and *Tilapia zilli* have longest dorsal fin length. Dorsal fin height shows significant different acrss all fishes. *Clarias gariepinus, Tilapia zilli, Labeo senegalensis and Siluranodon auratus* had short dorsal fin height while *Marcusenius senegalensis, Auchenoglanis biscutatus, Malapterus electricus* and *Synodontis nigriventris* had high dorsal fin height.

Table 2: Fin morphological properties of Some Selected Fish species from Kwatan Giwa River

Fish species	TFL	PFL	VFL	DFL	DFH
Clarias gariepinus	5.19±0.89[c]	3.12±1.11[a]	3.30±0.85[ab]	16.46±3.61[d]	2.39±0.71[ab]
Tilapia zilli	6.41±1.58[d]	5.54±1.18[b]	8.83±1.20[c]	15.90±1.32[d]	2.83±0.71[ab]
Labeo senegalensis	6.26±1.00[d]	3.21±0.80[a]	5.16±6.81[b]	8.18±1.86[a]	3.62±1.70[ab]
Marcusenius senegalensis	3.45±1.61[ab]	3.33±1.37[a]	3.41±0.80[ab]	13.16±4.47[c]	3.46±1.03[bc]
Auchenoglanis biscutatus	7.64±1.77[e]	4.77±1.37[b]	4.08±0.86[ab]	14.78±2.82[c]	3.92±5.25[bc]
Malapterus electricus	4.46±0.87[bc]	3.56±1.27[a]	3.97±1.01[ab]	10.13±4.14[b]	3.28±1.42[bc]
Synodontis nigriventris	6.72±1.40[de]	5.30±1.00[b]	4.64±0.93[b]	11.35±2.73[b]	5.13±0.57[c]
Siluranodon auritus	2.77±0.86[a]	2.76±0.80[a]	2.56±1.25[a]	7.49±2.45[a]	1.68±1.51[a]

Key: TFl=tail fin length, PFL= Pectoral fin length, VFL= Ventral fin length, DFL= Dorsal fin length, DFH=Dorsal fin height

Gut Contents of Selected Fish Species Collected From Kwatan Giwa River

The gut content analysis of eight fish species sampled from the Kwatan Giwa River provides direct insight into the trophic relationships and feeding strategies among aquatic fauna in this ecosystem. The results show a clear division between piscivorous predators and non-piscivorous prey species, illustrating predator-prey interactions and ecological roles. *Clarias gariepinus*, identified as a piscivorous predator, had gut contents containing scales and remains of *Tilapia* spp, juvenile *Synodontis, Labeo senegalensis,* and *Marcusenius senegalensis*. This highlights its generalist predatory behavior and its significant impact on juvenile fish populations in the river. *Marcusenius senegalensis* and *Synodontis nigriventris* also showed evidence of piscivory, feeding on Tilapia scales and juvenile *Labeo*, confirming their roles as active predators within the aquatic food web. *Malapterus electricus* consumed *Tilapia* and juvenile *Clarias*, affirming its role as a top predator, utilizing its electrogenic ability to immobilize prey. Its diet reflects specialization in fish prey, often targeting smaller or juvenile individuals. In contrast, *Tilapia* spp, *Labeo senegalensis*, *Auchenoglanis biscutatus*, and *Siluranodon auratus* showed no fish remains in their guts, indicating non-piscivorous diets.

Table 3: Gut Contents of Selected Fish Species Collected from Kwatan Giwa River

Sample	Fish species	Gut content	Feeding habit	Ecological interpretation
A	*Clarias gariepinus*	*Tilapia scale*, juvenile *Synodontis*, juvenile *Labeo senegalensis* and juvenile *Marcusenius senegalensis*	Piscivorous	Predator
B	*Tilapia spp*	-	Non-Piscivorous	Prey
C	*Labeo senegalensis*	-	Non-Piscivorous	Prey
D	*Marcusenius senegalensis*	*Tilapia scale*, juvenile *Labeo senegalensis*	Piscivorous	Predator
E	*Auchenoglanis biscutatus*	-	Non-Piscivorous	Prey
F	*Malapterus electricus*	*Tilapia* scale and juvenile *Clarias*	Piscivorous	Predator
G	*Synodontis nigriventris*	*Tilapia* scale and juvenile	Piscivorous	Predator
H	*Siluranodon auratus*	-	Non-Piscivorous	Prey

DISCUSSION

The findings from the study of selected fish species in Kwatan Giwa River provide critical insight into their taxonomic classification, morphological characteristics, and feeding habits. These results align with and expand upon existing literature in freshwater fish ecology.

Table 1 shows the lists the scientific and common names of the eight fish species collected, representing different ecological niches within the Kwatan Giwa River. The variety of species such as *Clarias gariepinus*, *Tilapia spp*, and *Malapterus electricus* reflects the biodiversity and ecological complexity of the river system. This diversity is comparable to findings from Akinwumi and Idowu (2016), who reported high species richness in similar tropical inland waters in Nigeria, particularly in the Lower Ogun River.

Morphometric traits such as tail fin length (TFL), pectoral fin length (PFL), and dorsal fin height (DFH) are important indicators of swimming ability, habitat preference, and feeding strategy. For example, *Auchenoglanis biscutatus* exhibited the highest TFL (7.64±1.77 cm), which supports its benthic and active foraging behavior, similar to observations by Adedeji and Okocha (2011) in Oyan Lake. In contrast, *Siluranodon auritus* recorded the lowest values across most fin parameters, suggesting limited locomotor capability and a preference for slow-flow or lentic habitats, consistent with findings by Olojo *et al*., (2005).

Interestingly, *Tilapia zillii* and *Synodontis nigriventris* showed relatively high dorsal fin height (DFH), indicating better maneuverability and stability in open water, which could facilitate their survival in mixed habitats. These fin attributes correspond with the habitat flexibility and ecological adaptability noted in the work of Olopade and Ayoade (2020), who reported similar adaptations among Cichlids and Mochokids in River Ogun.

Table 3 sheds light on the feeding behavior and ecological roles of the studied fish. The gut content analysis revealed a division between piscivorous (predatory) and non-piscivorous (prey) species. *Clarias gariepinus*, *Malapterus electricus*, and *Marcusenius senegalensis* were clearly piscivorous, with stomach contents including scales and juveniles of other species. This is in agreement with studies by Fagade and Olaniyan (1973), who also documented piscivory in *Clarias* species in Nigerian freshwater systems.

On the other hand, *Tilapia spp*, *Labeo senegalensis*, and *Siluranodon auratus* showed no evidence of fish in their gut contents, reinforcing their roles as primary or secondary consumers. Their diets likely consist of plankton, detritus, and plant materials, which aligns with findings by Komolafe and Arawomo (2008) in their study of Lake Asejire.

Predatory species like *Synodontis nigriventris* and *Marcusenius senegalensis* consumed juvenile and smaller fishes, indicating their impact on the population dynamics of more herbivorous species. This supports a classic food web structure, where energy transfer flows from non-piscivorous to piscivorous species.

When compared with other ecosystems, such as the River Niger Basin or Lake Chad, similar trophic structures are observed. For instance, Idodo-Umeh (2003) found that *Clarias gariepinus* maintained its position as a top predator across multiple West African freshwater systems. Likewise, *Tilapia spp* consistently function as herbivores and detritivores, as recorded by Abowei and Davies (2009) in the Niger Delta region.

CONCLUSION

The study successfully highlighted the relationship between fin size and predation strategies among selected fish species in the study area. Species with larger fins and well defined pectoral such as *Clarias gariepinus* were more likely to be successful predators due to enhanced swimming capabilities and also have higher advantage of environmental exploitation.

Recommendations

1) Regulatory measures should be put in place to prevent overfishing of key species, especially the predatory fishes like *Clarias gariepinus* and *Malapterus electricus*, which play a crucial role in controlling prey populations and maintaining ecological balance.
2) Efforts should be made to protect the natural habitats of these fish species from degradation due to pollution, deforestation, and human encroachment.
3) Periodic assessments of fish biodiversity, feeding patterns, and habitat health should be conducted to track ecological changes and detect early signs of ecosystem stress or imbalance.
4) Local communities around Kwatan Giwa River should be educated on the importance of aquatic biodiversity and involved in conservation efforts.
5) Detailed seasonal studies should be conducted to understand temporal changes in feeding habits, reproductive cycles, and population dynamics.

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Authors Contribution

All the authors collectively contribute to the conceptualization, Planning, Writing and compilation of the work while the final review was done by Isah M C. All authors read and approved the final manuscript.

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