International Journal of
Marine Life

ISSN: 3048-8885
Volume 2, Issue 1, 2025
January–June
DOI (Journal): 10.37591/IJML

https://journals.stmjournals.com/ijml

Research IJML

Investigating the Dietary Flexibility and Feeding Behavior of *Clarias anguillaris* and *Auchenoglanis biscutatus* in a Tropical River Ecosystem

Tivfa Samuel Gbaior[1], Joel Inya Odo[2], Charles Ifeanyi Odoh[3], Edward Terhemen Akange[1], Ayush Madan[4,*]

Abstract

Studies on food and feeding habits of fishes are required to guide the selection of fish species for culture. The current study determined the food and feeding habits of Clarias anguillaris and Auchenoglanis biscutatus in the Lower River Benue at Makurdi, Nigeria. Fish samples were collected biweekly from local fishermen at the Wadata landing site who fished with different gears like gillnets, cast nets, hook and line, traps and lift nets. Fish specimens were collected and transported in ice boxes to the laboratory for dissection and identification using a stereoscopic microscope. Percentages of food items for C. anguillaris ranged from sand/mud (3.75%) to Daphnia and insects (14.29%) using the frequency of occurrence method, the numerical method recorded a range of sand/mud (2.63%) and Daphnia (15.46%) while the volumetric method range was between detritus (2.86 %) and insects (whole/parts) with 7.77%. Results of the frequency of occurrence, numerical, and volumetric methods for A. biscutatus ranged from Daphnia and insects (7.10% each) – sand/mud (13.55%), plant materials (4.61%) – Annelids (15.46%) and Algae (2.77%) – sand/mud (18.14%), respectively. Dietary overlap analysis revealed notable similarities between the fish species, especially for insect parts and detritus. The high index of relative importance (IRI) values for specific food items showed that both fish species exhibited the omnivorous and opportunistic feeding habit. It is therefore concluded that both fish species are valuable choices for culture, having high dietary variability.

Keywords: Food sources, ecological stability, fish and adaptability, dietary overlap, stomach content analysis

***Author for Correspondence**
Ayush Madan
E-mail: madanayushmadan@gmail.com

[1]Lecturer, Department of Fisheries and Aquaculture, Joseph Sarwuan Tarka University, Makurdi, Nigeria.
[2]Lab Technologist, Department of Fisheries and Aquaculture, Joseph Sarwuan Tarka University, Makurdi, Nigeria
[3]Student, Department of Fisheries and Aquaculture, Joseph Sarwuan Tarka University, Makurdi, Nigeria
[4]Assistant Professor, Department of Biotechnology, School of Research & Technology, People's University, Bhanpur, Bhopal, Madhya Pradesh, India.

Received Date: February 12, 2025
Accepted Date: February 17, 2025
Published Date: March 07, 2025

Citation: Tivfa Samuel Gbaior, Joel Inya Odo, Charles Ifeanyi Odoh, Edward Terhemen Akange, Ayush Madan. Investigating the Dietary Flexibility and Feeding Behavior of *Clarias anguillaris* and *Auchenoglanis biscutatus* in a Tropical River Ecosystem. International Journal of Marine Life. 2025; 2(1): 1–9p.

INTRODUCTION

The study of fish feeding behavior is crucial to understanding aquatic food webs and ecosystem stability [1]. Fish feeding habits define the position of fish species at the trophic level, as predator-prey interactions [2]. and food partitioning within aquatic ecosystems are influenced by the feeding patterns [3]. Food studies represent the basis for the development of a successful fisheries management programme on fish harvesting and rearing. Fish diet has been reported to be an important determinant of fish growth, condition factor, fecundity [4]. and migratory patterns. These feeding patterns of fishes are jointly shaped by biological, environmental, and ecological factors. Biologically, fishes are classified based on their type of diet, those that feed on a variety of food types (plants and animals) are referred to as euryphagic feeders, those that feed on a specific diet type (plants or animals) are said to be stenophagic feeders while species that feed on a specialized diet are monophagic feeders. Each fish category possesses unique intestinal structures that aid digestive enzyme activities, thus facilitating nutrient absorption of ingested diets. Environmental variables like temperature and salinity affect feeding rates. Feeding activities are generally said to be higher at warmer temperatures while food availability and feeding efficiency are greatly influenced by pH levels [5, 6]. Emphasized the importance of ecological interactions, like predator-prey relationships in determining resources availability, which equally influence distribution and abundance of fish in an ecosystem.

Clarias anguillaris (mudfish), is a resilient African catfish species known to inhabit rivers, lakes, and reservoirs, contributing to artisanal fisheries [7]. The body is elongated without scales and possesses sensory barbels. The fish species is known to survive in low-oxygen environments and many a times exhibits isometric growth. *C. anguillaris* is an omnivore, with preference for small fishes, other food sources include insect larvae and organic debris (mud) though easily adjusts its diet based on the food available. It is currently listed as a species of least concern and thrives in different aquatic ecosystems [8]. *Auchenoglanis biscutatus*, commonly called the black spot catfish belongs to the African catfish family Claroteidae and it is predominantly found in freshwater bodies across Africa, including the Lower River Benue in Nigeria [9].

The species have been reported by researchers to often exhibit negative allometric growth, with its weight increasing more slowly relative to its length [10]. *A. biscutatus* feeds on a range of food sources, such as seeds, fish parts, detritus, algae, molluscs and insect parts as is often described as an omnivorous bottom feeder, but with more preference for animal food sources, especially insect larva. It is also highly adaptable to fluctuations in environmental variables.

These two fish species contribute to local fisheries as they often form a substantial part of landings by fishermen in the Lower River Benue which provides a unique environment characterized by seasonal floods with enriched nutrients. There exist few studies that have focused on the food and feeding habits of *C. anguillaris* and *A. biscutatus* in Lower River Benue, mostly especially on the aspects of dietary overlap and resource competition. This study therefore aims to analyze and compare the diet composition and feeding preferences between the two fish species to provide information as potential species as culture.

MATERIALS AND METHODS

Study Area

The study was carried out in Lower River Benue (Figure 1) located within Makurdi, Nigeria. This part of the river runs between Benue and Kogi States of Nigeria and gets it supply from the Adamawa Mountains of Cameroun and flows west across East-Central Nigeria. It is the widest tributary of the Niger which terminates at Lokoja in Kogi State, Nigeria. The river covers approximately 187 kilometers. The extensive flood plain forms breeding grounds for many fish species. Garrison and Link (2000) [11] reported that the river system serves as a major ecological and economic resource, supporting wide fish biodiversity and artisanal fishing activities. River Benue experiences tropical climate conditions, with distinct wet and dry seasons. This variation in water level is known to affect fish species' availability throughout the year. The diverse fish communities available in the river play an essential role in the freshwater ecosystem of the nation, supporting both local communities and regional biodiversity [12].

Sampling Procedure

Fish specimens for both *C. anguillaris* and *A. biscutatus* were collected fortnightly between November 2022 and January 2023 from the landings of fishermen at Wadata, Makurdi, Benue State. Fish were caught using assorted gears which included gill nets, cast nets, traps and hooks and lines. Fish identification was carried out using the field guide of Nigerian freshwater fishes by Herawati et al. (2024) [13]. Samples were transported in ice boxes to the Nutrition Laboratory in the Department of Fisheries and Aquaculture, Joseph Sarwuan Tarka University, Makurdi for analysis [12].

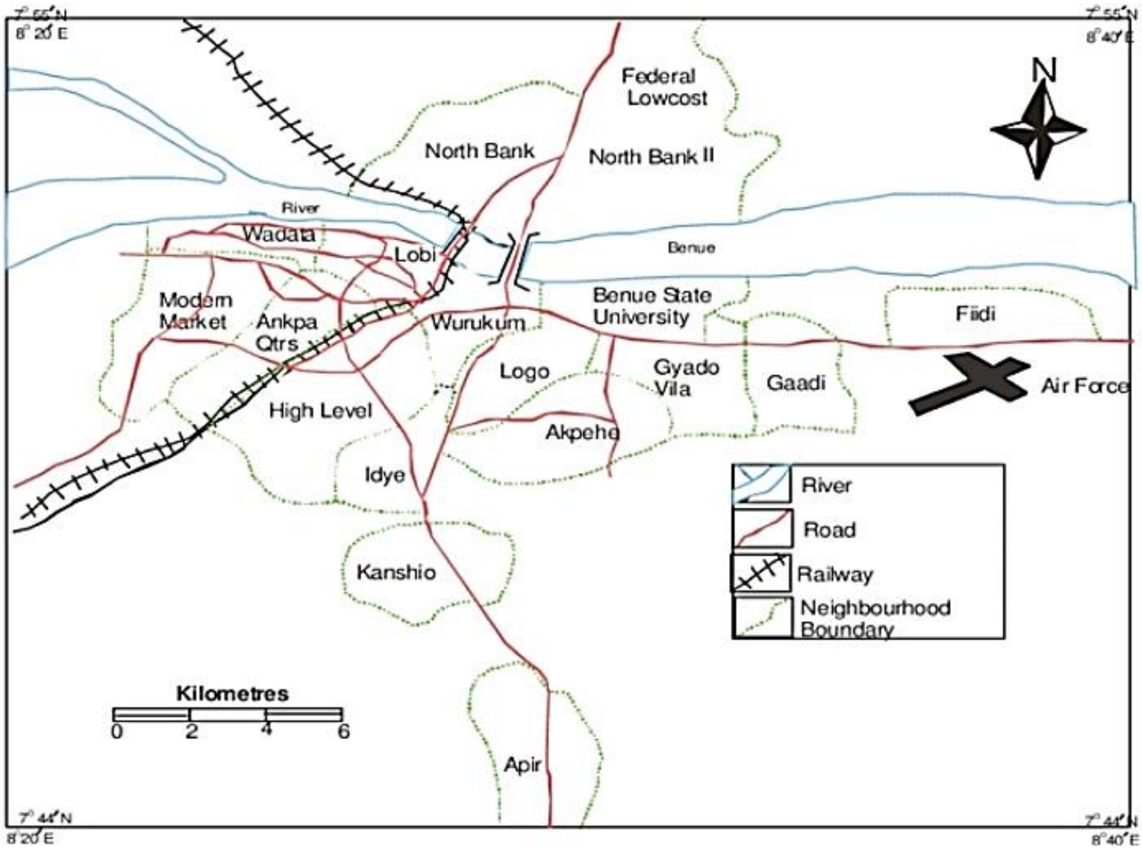

Figure 1. Map showing the Lower River Benue basin.

Laboratory Procedure

In the Laboratory, some morphometric features of each fish were taken which were the total length (TL) to the nearest 0.1 centimeter using an ichthyoboard and body weight (BW) measured to the nearest 0.01 gram using an electronic weighing balance (MH-999). The total length was measured from the tip of the snout to the tip of the tail. Fish were then dissected, and guts were removed, then weighed with or without food [14]. Gut contents were emptied in sterile petri dishes and viewed under a stereoscopic microscope for identification. Large food items were easily identified with naked eyes while a solution of 10% formalin was used to preserve food items that were difficult to be seen immediately for future identification [15].

STOMACH CONTENT ANALYSIS

Three complementary methods of stomach content analysis were employed which included frequency of occurrence, numerical and volumetric methods as described by Jiang et al. (2022) [16]. In the frequency of occurrence method, the number of occurrences of each food item was expressed as the percentage of the total number of stomachs containing food as given below:

$$\text{\% Occurrence of a food item} = \frac{total\ number\ of\ stomachs\ with\ the\ particular\ food\ item}{total\ number\ of\ stomachs\ with\ food} \times 100 \quad (1)$$

The numerical method involved counting each food item to establish relative abundance as given in the formula below:

$$\text{\% number of a food item} = \frac{total\ number\ of\ the\ particular\ food\ item}{total\ number\ of\ all\ food\ items} \times 100 \quad (2)$$

The volumetric method on the other hand estimated the volume of each prey item to understand their dietary importance. The formula is given as follows:

$$\% \text{ volume of a food item} = \frac{volume\ of\ the\ particular\ food\ item}{total\ volume\ of\ stomach\ contents} \times 100 \quad (3)$$

The Index of Relative Importance (IRI) was calculated for each food item according to (Lorenzoni et al., 2002). This index provides a quantitative measure of the importance of various food items in the diet of the fish [17]. It is given as follows:

$$IRI = (\%F + \%N + \%V) \quad (4)$$

Data Analysis

Data from stomach content analysis was subjected to statistical analysis ($P < 0.05$) using Microsoft Excel to determine the dietary overlap between the two fish species. The dietary overlap index calculated provided information to the extent to which the food resources identified were shared between *C. anguillaris* and *A. biscutatus*. It also gave an idea of the potential competition between the fish species in an ecosystem [18].

RESULTS

A total number of 96 specimens of *Clarias anguillaris* and *Auchenoglanis biscutatus* were obtained with each fish species comprising 48 specimens. The total length for *C. anguillaris* ranged from 12.50 to 36.20 cm with a mean length of 24.67 ± 2.05 cm while *A. biscutatus* recorded a total length range of 10.70 to 31.50 cm with a mean length of 21.43 ± 1.62 cm. The body weight ranged between 124.30 and 508.60 g with a mean weight of 382.36 ± 18.29 g and 98.40 to 475.30 g with a mean weight of 279.81 ± 13.27 g for *C. anguillaris* and *A. biscutatus*, respectively. Figures 2 and 3 show the stomach fullness analysis of the two fish species. *C. anguillaris* had the highest and lowest number of empty stomachs in January 2023 (41.76%) and November 2022 (23.52%), respectively while full stomachs were highest in November and December 2022 with 11.76% each and the lowest number recorded in January 2023 (5.88%). Empty stomachs were lowest (20%) in November 2022 and highest (40%) in January, while the highest number of full stomachs was recorded in November 2022 and January 2023 (13.33% both) and lowest number of full stomachs occurred in December 2022 for *A. biscutatus*.

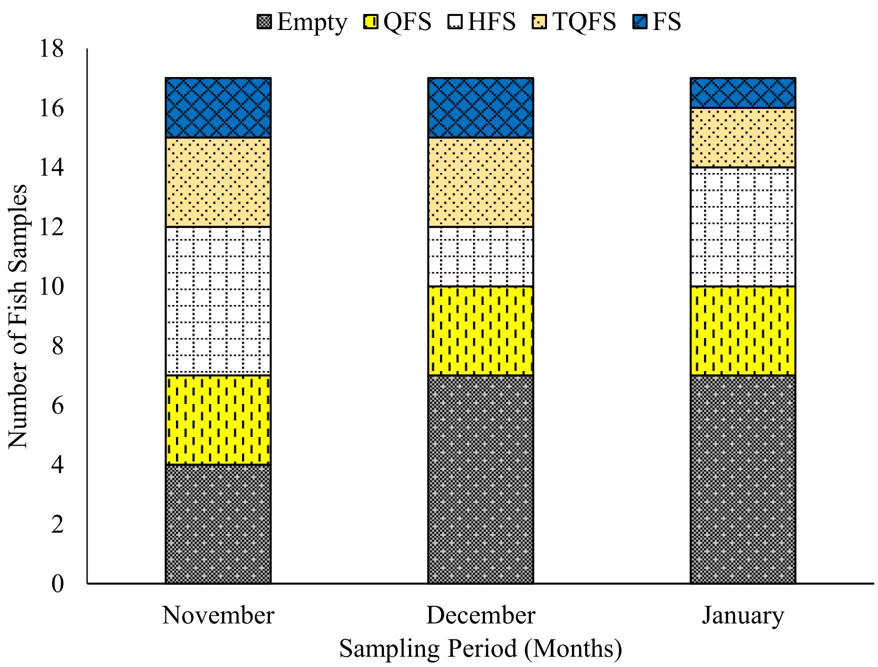

Figure 2. Stomach fullness of *Clarias anguillaris*.

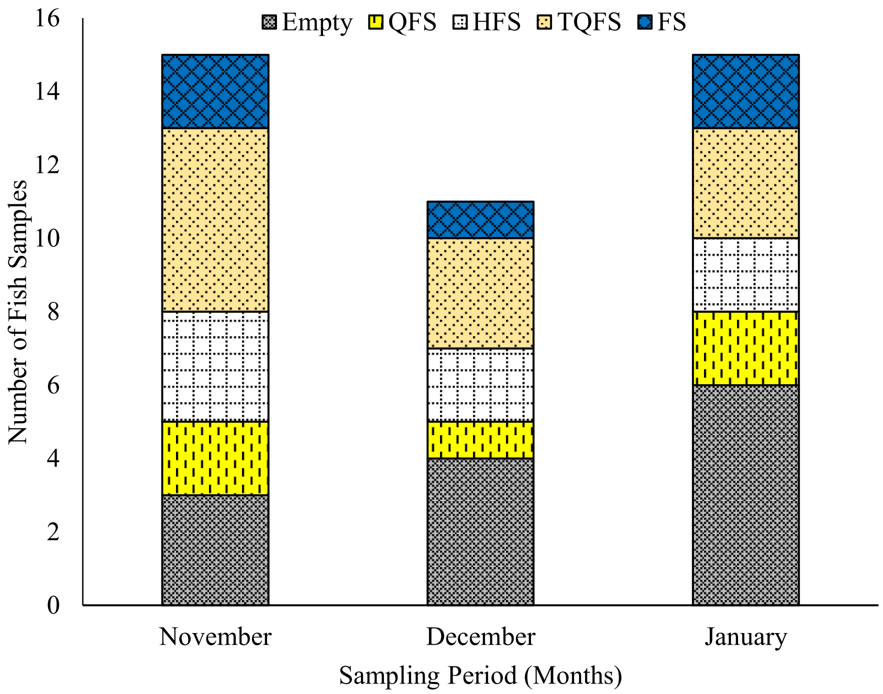

Figure 3. Stomach fullness of *Auchenoglanis biscutatus*.

Food Composition of *Auchenoglanis biscutatus* and *Clarias anguillaris*

Analysis of the stomach contents of *Auchenoglanis biscutatus* (Table 1) revealed variety food items dominated by Sand/mud (13.55%) for the frequency of occurrence method, then followed by molluscs and annelid (12.6% both), digested food particles (11.61%), detritus (10.97%), insect larvae (9.68%). Other food items recorded were algae and plant material (7.74% both) while the food types that least occurred in the dissected stomachs were daphnia and insects (whole/part) with a 7.10% each. The numerical method showed that Annelids found in the stomach of the fish species had the highest total number of occurrences (15.46%) and the lowest recorded was plant materials (4.61%) while the volumetric method revealed that sand/mud recorded the highest volume of 18.14% and algae have the lowest (2.77%). In contrast, *C. anguillaris* (Table 2) exhibited a different dietary pattern, with daphnia and insect parts being the most frequently occurring items (14.29% each). The volumetric method showed insect parts as the highest component (7.77%), indicating a strong omnivorous tendency with more surface or column feeding behaviors [19].

Table 1. Food composition in the stomach of *Clarias anguillaris*.

	Methods of Stomach Content Analysis			IRI
Food Items	***%F***	***%N***	***%V***	
Algae	13.10	9.21	3.84	8.13
Daphnia	14.29	7.89	5.63	9.19
Molluscs	11.31	8.88	5.90	7.95
Insect (whole/parts)	14.29	15.46	7.77	15.79
Insect Larvae	13.69	8.88	8.49	11.31
Annelids	8.93	6.58	3.13	4.12
Digested food particles	8.33	3.95	5.00	3.55
Plant Materials	7.74	2.96	3.66	2.44
Detritus	4.76	3.29	2.86	1.39
Sand/Mud	3.57	2.63	5.72	1.42

Table 2. Food composition in the stomach of *Auchenoglanis biscutatus*.

Food Items	Methods of Stomach Content Analysis			IRI
	%F	*%N*	*%V*	
Algae	7.74	14.14	2.77	6.23
Daphnia	7.10	7.57	2.86	3.52
Molluscs	12.26	5.92	10.01	9.29
Insect (whole/parts)	7.10	6.91	11.89	6.35
Insect Larvae	9.68	12.17	8.94	9.72
Annelids	12.26	15.46	9.12	14.33
Digested food particles	11.61	9.87	13.40	12.86
Plant Materials	7.74	4.61	9.56	5.22
Detritus	10.97	9.87	13.32	12.10
Sand/Mud	13.55	13.49	18.14	20.39

Dietary Overlap

The dietary overlap index between *Auchenoglanis biscutatus* and *Clarias anguillaris* (Table 3) indicated significant overlap for detritus and insects. This overlap shows shared dietary resources between the fish species, suggesting limited competition for specific food items [20].

Table 3. Dietary Overlap between *Clarias anguillaris* and *Auchenoglanis biscutatus*.

Food Items	Dietary Overlap Index	Sig (P < 0.05)
Algae	0.29	0.20
Daphnia	0.04	0.59
Molluscs	0.21	0.26
Insects (whole /parts)	0.90	0.05*
Insect Larvae	0.13	0.37
Annelids	0.05	0.55
Digested Food Particles	0.07	0.48
Plant Material	0.13	0.37
Detritus	0.65	0.04*
Sand/Mud	0.37	0.16

Note: *significant at $P < 0.05$.

DISCUSSION

The analysis of the dietary habits of *Clarias anguillaris* and *Auchenoglanis biscutatus* provides crucial data on the feeding ecology and trophic levels of these species within the Lower River Benue ecosystem. Both *C. anguillaris* and *A biscutatus* [21] species exhibited omnivorous feeding patterns. This is confirmation of their adaptability to a variety of available food resources. This dietary flexibility permits these fish species to exploit seasonal changes in food resources availability normally experienced by tropical river ecosystems. The results of the current study agree with previous research by [22], who reported similar feeding habits for the same species in the Cross River ecosystem. The primary dietary food items identified in guts of *A. biscutatus* were sand/mud, molluscs, detritus, and annelids. The findings of the current study are consistent with that of [23], they also outlined similar food items as diet composition of the same fish species from the Lower River Benue utilizing the frequency of occurrence and point methods for stomach content analysis. The high composition of sand/mud in the diet of this fish species is a clear indication that it is a bottom-feeder. This means that the fish species fed mostly along the riverbed, and it could lead to feeding on benthic food organisms intentionally and at the same time accidentally ingesting substrate materials. Studies by Pratiwy et al. (2024) [24], had also confirmed the presence of sand and mud in stomachs of benthic feeders, consequent their feeding pattern. During the process of feeding, the benthic feeders explore sifting through substrates for organic matter and micro invertebrates. This feeding orientation is further verified by the presence of annelids and mollusk as they typically reside within the substrate. The consumption of detritus, which is a common food source in rivers demonstrates the role of *A. biscutatus* in the recycling of organic matter, making it a contributor to nutrient cycling in the water body. *C. anguillaris* however showed a broader dietary spectrum by foraging on pelagic food items like daphnia together with benthic organisms like insect larvae, detritus, and sand/mud. Radhakrishnan et al. (2020) [25] also reported *A. biscutatus* as an omnivore with substantial number of insects as part of their diet composition in Tiga Lake, Kano State and Sebore Reservoir, Mayo–Belwa of Adamawa State, respectively. This extended selection of food items means the fish species is more of an opportunistic feeder that explores both benthic and pelagic niches within the Lower River Benue. For the fish to also feed on daphnia, it means that it can even feed around the open water columns unlike *A. biscutatus* which is primarily benthic feeder. This is also an adaptative strategy for the fish species as it can take competitive advantage of variation in food resources in ecosystems orchestrated by seasonal changes.

There was a substantial overlap of diet composition between the two fish species especially for detritus and insect larvae consumption. The significant overlap in these categories ($P < 0.05$) shows the possibility of competition for food resources, especially in periods of low abundance of food items [26]. The presence of similar food items, such as insect parts, detritus, and sand/mud reflect their shared feeding preferences and the possibility of interspecies interactions within the same habitat zone. Nevertheless, there is evidence of niche differentiation despite the dietary overlap as *A. biscutatus* appears to feed more on benthic food organisms while *C. anguillaris* demonstrates flexibility by feeding not only in the benthic zone but also into the pelagic zone, thus having the chance to utilize zooplankton as a food source. Resource partitioning plays a role in reducing competition between these fish species to an extent [27]. For example, seasonal changes (dry to wet) can significantly influence the availability of food organisms. Increases in water levels during the rainy season could lead to higher food availability as nutrients and organic materials flow from surrounding into the river, thus augmenting growth of different food resources of both plant and animal origin. Diet expansion can occur during such periods which reduces direct competition. On the other hand, dietary overlap seems to be more prevalent during the dry season when food resources are less available and as a result limited competition between fish species is intensified. Edem and Opeh [28] noted that this seasonal variation in the abundance of food organisms is an important factor in the coexistence of multiple omnivorous species within the same ecosystem. The shared omnivorous feeding pattern by *C. anguillaris* and *A. biscutatus* will permit them to perform valuable roles in the ecosystem stability of Lower River. As a result of their feeding variability, consuming both animal and plant materials, these fish species contribute to the control of prey populations and the recycling of organic matter, which by implication helps in maintaining the ecological balance [29]. This is specifically demonstrated in the aspect of nutrient cycling by feeding on detritus which helps in the decomposition of organic matter, thus supporting trophic structure of the river. This dual role as both predators and detritivores makes the two fish species integral components of the food web, influencing both lower trophic levels through the consumption of zooplankton and insect larvae and at the higher levels by serving as a food source for larger predators.

In terms of the potential of these two species for culture fisheries, the findings of the current studies qualify them as suitable fish stocks for polyculture systems. Their variation in dietary preferences reduces the need for industrial high-cost feed inputs, which is an advantage in low-cost, sustainable aquaculture practices. Furthermore, their pattern of feeding on both plant and animal food sources allows them to coexist with other species in shared environments without direct competition for specific food items [30], only if the diet is adjusted to meet nutritional requirements. Their adaptability and tolerance for variation in environmental parameters combined *C. anguillaris* and *A. biscutatus* potential profitable seeds for multi-species aquaculture practices that maximize yield while minimizing ecological impact [31].

CONCLUSIONS

The feeding habits of *Clarias anguillaris* and *Auchenoglanis biscutatus* demonstrates their roles as omnivorous benthic feeders within the Lower River Benue ecosystem. The diverse food items ingested by the two fish species and significant dietary overlap make them adaptable to varying environmental conditions, making them profitable for aquaculture. Their diet range will reduce the cost of feed production in culture systems, making them suitable for polyculture practices in sustainable fisheries.

REFERENCES

1. Akombo PM, Atile JI, Shima JN. The Growth Parameters and Mortalities of Five Species of Synodonits in the Lower River Benue at Makurdi. J Zool Res. 2021 Aug 5;3(3):33–43.
2. Akombo PM, Cheikyula JO, Kwaghvihi OB. Recruitment, Exploitation, Relative Yield per Recruit and Mortality of Synodontisschall (Bloch and Schneider, 1801) in Lower River Benue at Makurdi. Octa J Environ Res. 2017 Sep 1;5(3).
3. Ayanwale A, Oloruntoba O, Keke U, Samuel P. Temperature effects on the opercular respiratory rates of Clarias anguillaris fingerlings reared under Laboratory conditions in Minna, Nigeria. Egypt J Aquatic Biol Fish. 2020 Aug 27;24(6):47–58.
4. Bonjoru R, Abubakar KA, Hassan EI, Jerry TJ. Diversity and Abundance of Fish Species in Some Selected Riverine Wetlands of Upper Benue River Basin, Nigeria. J Environ Sci Toxicol Food Technol. 2019;13(8):14–8.
5. Brodeur RD, Smith BE, McBride RS, Heintz R, Farley E. New perspectives on the feeding ecology and trophic dynamics of fishes. Environ Biol Fish. 2017 Apr;100:293–7.
6. Chatterjee A, Pal S. A predator-prey model for the optimal control of fish harvesting through the imposition of a tax. An International Journal of Optimization and Control: Theories & Applications (IJOCTA). 2023 Jan 26;13(1):68–80.
7. Danet A, Mouchet M, Bonnaffé W, Thébault E, Fontaine C. Species richness and food-web structure jointly drive community biomass and its temporal stability in fish communities. Ecol Lett. 2021 Nov;24(11):2364–77.
8. Dias RM, Ortega JC, Gomes LC, Agostinho AA. Trophic relationships in fish assemblages of Neotropical floodplain lakes: selectivity and feeding overlap mediated by food availability. Iheringia. Série Zoologia. 2017;107:e2017035.
9. Dutta S. Feeding ecology, trophic interaction and resource partitioning among four omnivorous finfish species of a tropical Estuary. Int J Limnol. 2022;58:12.
10. Goldstein RM, Simon TP. Toward a united definition of guild structure for feeding ecology of North American freshwater fishes. InAssessing the sustainability and biological integrity of water resources using fish communities. CRC Press. 2020 Aug 26. pp. 123–202.
11. Garrison LP, Link JS. Dietary guild structure of the fish community in the Northeast United States continental shelf ecosystem. Marine Ecol Progress Series. 2000 Aug 28;202:231–40.
12. Heng K, Chevalier M, Lek S, Laffaille P. Seasonal variations in diet composition, diet breadth and dietary overlap between three commercially important fish species within a flood-pulse system: The Tonle Sap Lake (Cambodia). PloS one. 2018 Jun 18;13(6):e0198848.
13. Herawati EY, Wiratno EN, Rusydi AN, Elisabet O, Valina R. Analysis of Feeding Habits and Biological Aspect of Yellow Stripe Trevally (Selaroides leptolepis) Caught at the Lekok Coast, Pasuruan, East Java. InIOP Conference Series: Earth and Environmental Science. IOP Publishing. 2024 Apr 1;1328(1):012001.
14. Hyslop EJ. Stomach contents analysis—a review of methods and their application. J Fish Biol. 1980 Oct;17(4):411–29.
15. Jiao F, Zhang L, Limbu SM, Yin H, Xie Y, Yang Z, et al. A comparison of digestive strategies for fishes with different feeding habits: Digestive enzyme activities, intestinal morphology, and gut microbiota. Ecol Evol. 2023 Sep;13(9):e10499.
16. Jiang M, Xiao W, Ye J, Xu L, Peng R, Han Q, et al. Effects of feed transition on digestive tract digestive enzyme, morphology and intestinal community in cuttlefish (Sepia pharaonis). Front Marine Sci. 2022 Sep 6;9:941488.
17. Lorenzoni M, Corboli M, Doerr AJ, Giovinazzo G, Selvi S, Mearelli M. Diets of Micropterus salmoides Lac. and Esox lucius L. in Lake Trasimeno (Umbria, Italy) and their diet overlap. Bulletin Francais de la peche et de la pisciculture. 2002(365–366):537–47.

18. Ludwig KE, Singer A, Kröncke I, Sell AF. Predator-prey trait associations and feeding preferences of demersal fishes in the southern North Sea. Marine Ecology Progress Series. 2024 Jul 4;739:173–90.
19. Meye JA, Ikomi RB. Food and Feeding Habits of Auchenoglanis biscutatus (Geoffrey St. Hilarie, 1827) in River Orogodo, Delta State, Nigeria. J Fish Int. 2010;5(4):67–71.
20. Moraes G, de Almeida LC. Nutrition and functional aspects of digestion in fish. InBiology and physiology of freshwater neotropical fish. Academic Press. 2020 Jan 1. pp. 251–271.
21. Neves MP, Kratina P, Delariva RL, Jones JI, Fialho CB. Seasonal feeding plasticity can facilitate coexistence of dominant omnivores in Neotropical streams. Rev Fish Biol Fish. 2021 Jun;31:417–32.
22. Offem BO, Akegbejo-Samsons Y, Omoniyi IT. Aspects of ecology of Clarias anguillaris (Teleostei: Clariidae) in the Cross River, Nigeria. Turkish Journal of Fisheries and Aquatic Sciences. 2010 Mar 1;10(1).
23. Hyslop EJ. The growth and feeding habits of Clarias anguillaris during their first season in the floodplain pools of the Sokoto-Rima river basin, Nigeria. J Fish Biol. 1987 Feb;30(2):183–92.
24. Pratiwy FM, Haetami K, Sinaga JA. Exploring fish eating habits: Factors influencing feeding behavior in tropical fish. Asian J Fish Aquatic Res. 2023 Jul 7;23(4):1–7.
25. Radhakrishnan G, Shivkumar VS, Yashwanth BS, Pinto N, Pradeep A, Prathik MR. Dietary protein requirement for maintenance, growth, and reproduction in fish: A review. J Entomol Zool Stud. 2020;8(4):208–15.
26. Farahiyah IJ, Zainal Abidin AR, Ahmad A, Wong HK. Optimum protein requirement for the growth of Jelawat fish (Leptobabrbus hoevenii). Malaysian J Animal Sci. 2017 Dec 1;20(2).
27. Sinare Y, Boungou M, Gneme A, Oueda A. Diversité et Dynamique des Cestodes chez Clarias Anguillaris au Burkina Faso. ESI Preprints. 2023 Jan 30;13:578–.
28. Edem ET, Opeh PB. Food and feeding habits of black spot cat fish (Auchenoglanis biscutatus) from Lower River Benue, Makurdi. Asian J Fish Aquat Res. 2018;1(3):1–5.
29. Tsevenda CA, Annune PA, Olufeagba SO, Ataguba GA. Food and Feeding Habits of Three Selected Fish Species of Lower River Benue, Benue State, Nigeria. Nigerian J Fish Aquaculture. 2024 May 29;12(1):1–5.
30. Wanjari UR, Mukherjee AG, Gopalakrishnan AV, Murali R, Kannampuzha S, Prabakaran DS. Factors affecting fish migration. InCurrent Status of Fresh Water Microbiology. Singapore: Singapore: Springer Nature; 2023 Nov 27. pp. 425–437.
31. Tamario C, Sunde J, Petersson E, Tibblin P, Forsman A. Ecological and evolutionary consequences of environmental change and management actions for migrating fish. Front Ecol Evol. 2019 Jul 10;7:271.

