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ORIGINAL RESEARCH ARTICLE

Ichthyofauna Diversity and Morphometric Analysis in an Anthropogenically Stressed Water Body Downstream of Jebba Dam, Nigeria

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ABSTRACT

Fishery resources are on the decline due to incessant and unregulated fishery activities practiced in most parts of the globe. This study investigated the fish composition of an anthropogenically stressed water body in Nigeria (Downstream Jebba Dam). Samples were collected using standard methods and procedures. A total of 6,850 fish belonging to 17 families and 25 species were collected from the sampled stations. Fish composition shows the Mochokidae family with the most dominant species at 29.33% and represented *Synodontis batensoda,* which was well distributed in all the study stations but highest in the station with 934 individuals, while the Gymnarchidae family was the least recorded with 0.16% and represented *Gymnarchus niloticus*. Length-Weight relationship (LWR) value ranged between 0.0018 and 0.215 (b <3) for the dominant fish species, indicating negative allometric growth as the fish species grows in length faster when compared to the weight. In terms of mean condition factor (K of the dominant fish species of Downstream Jebba Dam, *Cynothrissa mento* had the highest with 10.09, followed by *Oreochromis niloticus* (9.82), *Mugil cephalus* (9.02), *Labeo coubie* (3.72), *Bagrus bayad* (0.90), *Alestes macrolepidotus* (0.52), *Clarote laticeps* (0.31), *Momyrus rume* (0.26), *Clarias gariepinus* (0.19) and *Citharinus citharus* (0.16). The high condition factor (>1) observed in some fish indicates that these fish species were physiologically stable and successful well, while those with less than (<1) mean value implied that it was physiologically unstable, as showed in some species. Overall, the medium abundance of fish species in this study is an indication of an impaired water system.

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INTRODUCTION

Fish populations or abundance respond to various factors such as unregulated fishing, point and non-point source pollution, eutrophication, and land use type, which can result in variation in the sizes, species assemblage, distribution, and abundance of fish in aquatic habitat environments (Mohammed *et al.,* 2021a; Ibrahim *et al.,* 2022). Favourable environmental conditions are another factor that is responsible for fish species abundance in water bodies globally (Froese and Pauly 2018). The freshwater ecosystem of Nigeria is on the decline due to numerous anthropogenic activities around water bodies coupled with the land used type (Mohammed *et al.,* 2020; Mohammed *et al.,* 2021b; Oladipo *et al.,* 2021). Due to overexploitation and poor management of inland water bodies, Nigeria's fisheries resources are currently declining (Adamu *et al.,* 2021a,b). To ensure the sustainability of fishery resources, it is necessary to have a sufficient understanding of the species composition and their diversity with abundance in major water bodies in the country (Adadu *et al.,* 2019; Adamu *et al.,* 2021a,b). One of the most important factors that contribute to changes in fish diversity and composition in freshwater bodies of Nigeria is indiscriminate and unregulated fishing, which exerts significant pressure on the fishery composition of Nigeria (Adadu *et al.,* 2019; Adamu *et al.,* 2021a,b Oladipo *et al.,* 2021). Due to anthropogenic such as industrialization, urbanisation, and farming activities coupled with pressure from artisanal fishermen in our water bodies, fishery resources are declining, and fishes are migrating downstream in most cases in need of food and good habitat for spawning (Kumar and Asiji, 2009).

The development of the Jebba can be attributed to the building of hydro-electric power plants (Dam) in 1975.

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Even though the Jebba Dam was built to raise the living standard of the public, the aquatic ecosystem and the biotic community are at risk due to the rate at which anthropogenic activities are increasing within the water body (Oladipo *et al.,* 2021). This has resulted in the degradation of habitat and, eventually, in the disturbance of the water discharge's spatiotemporal pattern. The region's fisheries resources are frequently threatened by overexploitation, ongoing, indiscriminate fish harvesting, and pollution (Oladipo *et al.,* 2021). These dangers may have the unintended consequence of reducing the size of the population, trawling fish, and gene pool depletion (Aliko *et al.,* 2010).

In Nigeria and throughout Africa, fish are among the greatest and most important sources of animal protein for diet (Adadu *et al.,* 2019; Adamu *et al.,* 2021a,b Mohammed *et al.,* 2021a). Different biotic and abiotic condition influence fish species assemblages and their diversity in streams and rivers. As the human population keeps increasing, fish species in the River Niger are being lost due to numerous anthropogenic factors such using of chemicals for fishing, overfishing, using undersized marshes, spraying herbicides by rice farmers, and disposing of waste materials (Adadu *et al.,* 2019; Adamu *et al.,* 2021a,b; Mohammed *et al.,* 2021a). Different studies on fish assemblage have been carried out around the Jebba Hydro-electric Dam (Oladipo *et al.,* 2021) using both taxonomic and molecular methods, but no recent data on the morphometric composition of fishes downstream of Jebba Dam. Thus, this study is designed to assess the composition, diversity, distribution, and Morphometric of fish in the River Niger Downstream Jebba dam.

MATERIALS AND METHODS

Description of the study area

The study was carried out downstream of Jebba dam, Niger State; River Niger surrounds Jebba town. The northern part is called Gungun, in Mokwa local Government Niger state, and south in Kwara State Moro local Government area. Jebba Dam falls within the Guinea savannah of the Northcentral part of Nigeria, characterized by two (Dry and wet) seasons (Adelakun *et al.,* 2017). The river is located between longitude 4°49'34.11'E and latitude 9°7' 9.31'N or 4°82'61.42 and 9°11'92.52 respectively. The majority of the people in the studied are artisanal fishermen and traders while few of them engage in agricultural activities around the river bank.

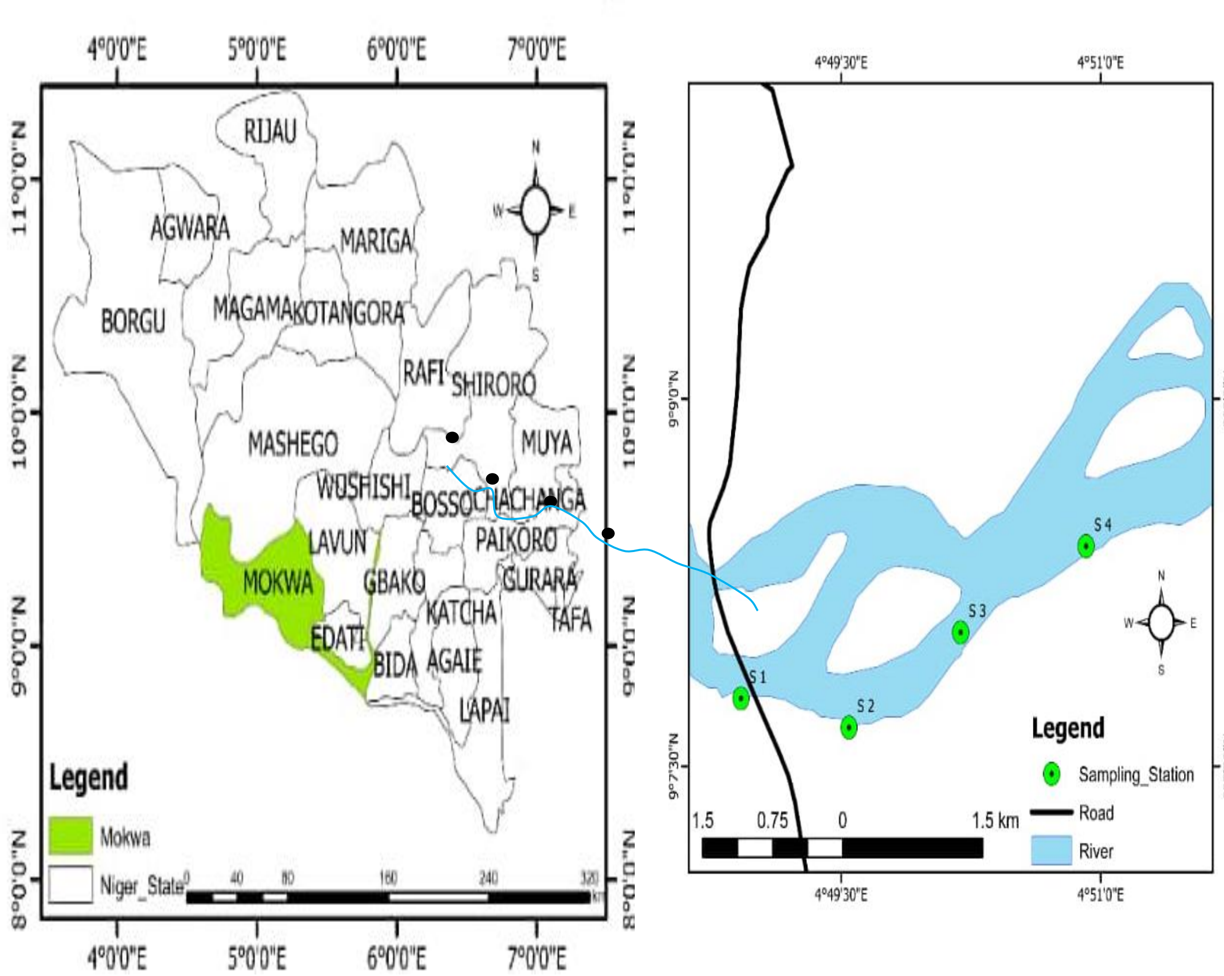

Figure 1: Map of River Niger showing the four stations

Sampling stations

Station 1 is popularly called Inda doku, and it is located below Jebba Bridge, close to the Jebba water board. This station has a less human settlement with high anthropogenicity like farming, washing of cars, swimming, domestic uses, washing of clothes, and plates, among others. Station 2 is called Kpata Sarki by the locals, and it is located 200 meters from the Jebba Paper mill industry. This station is characterized by some natural vegetation with scattered human settlements, and several anthropogenic activities such as farming, grazing of livestock, and laundry activities are common in this site. Station 3 is called Tsamanagi, and it is located 200 meters away from Jebba Paper Mill. Agricultural activities and other anthropogenic activities at the river bank characterize this station. The river bed is dominated by projected rocks, alluvia deposits, sand, and mud at some parts of the site. Station 4 is called Fanga, and it is approximately 200 meters away from station 3. This station is characterized by low human settlement with more agricultural activities such as farming and fishing

Collection of fish sample

The fish data and samples were collected from the fishermen at different major landing sites between 8 am to 10 am, and the sites were sampled weekly. For the periods of seven months (November 2021 to January 2022 and June 2022 to September 2022), making up three months in the dry season and four months in the wet season. Fish sampling was by direct observation of the fish at the landing sites, and collected fish were sorted into taxonomic groups, counted, and identified from family to species level by use of an identification guide and each species of the fishes collected was preserved and transported in a cool box to the laboratory of Animal Biology department of Federal university of technology Minna.

Determination of the morphometrics of fishes

Standard Length (S.L): It is the measurement of the distance between the tail fin to the tip of the fish's mouth using tape or thread (Wu and Huang, 2017). Total Length (T.L) is the measurement from the tip of the fish's mouth to the tail tip; thread can used and later measured on a ruler or tape on a flat surface (Wu and Huang, 2017). The body weight of the dominant fish species was measured to the nearest (0.1g) with a portable weighing balance (Adelaku *et al.,* 2017)

Data analysis

All data collected were typed in Microsoft Excel 2016 edition. The fish assemblage and distribution were subjected to diversity indexes such as Shannon-Weiner index (H), Simpson dominance index (C), and Margalef species richness index (D), while the length-weight relationship was subjected to descriptive statistics. Also, the Regression coefficient (b), correlation coefficient (r), and the condition factor of the dominant fishes were all analyzed using PAST (Paleontological statistical software tool) version 4.05.

RESULTS

Fish species composition and distribution in downstream Jebba Dam.

Table 1 shows a total of 6,850 fish belonging to 17 families and 25 taxa encountered during the study period in downstream Jebba Dam, Kwara state. Fish species composition and distribution in this study shows Mochokidae family was the dominant species with 29.33% and represented *Synodontis batensoda,* which was distributed across all the studied stations but highest in station with 934 individuals, while the Gymnarchidae family was the least recorded with 0.16% and represented *Gymnarchus niloticus*. The family Cyprinidae recorded 21.47% of the total catch and was represented by *Labeo coubie* which was well distributed in all stations. The Characidae family recorded about 8.51% of all the total catch and was represented by 3 species, namely, *Aleste baremose, Aleste macrolepidotus,* and *Hydrocynus forskali*. *Aleste baremose* was the most dominant species in this family, and none of them was recorded in station 4. The Mugilidae family was representative of *Mugil cephalus* only and accounted for 7.8% of the total catch, which was distributed in all stations. The family Centropomidae was represented with one species (*Lates niloticus*), and it account for 0.95% of the total catch. Malapteruridae was represented by *Malapterurus electrical,* which accounts for 0.25% of the fish catch and was only found in stations 1,2 and 3. Osteoglossidae was represented by *Heterotis niloticus* only, which accounted for 0.29% of the total catch, and it was distributed sparsely in all stations. Claridae family also recorded one species which is *Clarias gariepinus,* which accounts for 3.37% of the total catch and is evenly distributed in all stations. Family Gymniridae was represented by just a species (*Sting rays*), which accounted for 0.29% of the total catch and were slightly distributed in all stations. The family Claroteidae was represented by two species (*Auchenoglanis biscutatus* and *Clarotes laticeps*), which account for 2.2% of the total catch. The family Schilbeidae was represented by *Eutropius niloticus* and accounted for 0.72% of the total catch recorded. The family Cichlidae accounts for 12.47% of the total catch and was represented by 3 species, namely *Tilapia zilli*, *Oreachromis niloticus,* and *Sarotherodon* sp. The family Clupeidae accounted for about 3.42% of the total catch and was represented by *Cynothrissa mento.* The family Mormyridae accounted for about 3.32% of the total catch, and it was represented by 3 species, namely, *Mormyrus rume*, *Mormyrops deliciousus,* and *Hyperopisus bebe.* The family Bagridae accounted for about 3.07% of the total catch and was represented by 2 species, namely, *Bagrus bayad* and *Bagrus docmac.* The family Citharinidae was represented by *Citharinus citharus* and accounted for 2.20% of the total catch. The family Osteoglossidae was represented by *Heterotis niloticus* only, which account for 0.29% of the total catch.

Table 1: Fish species composition and distribution in Downstream Jebba Dam (November 2021-September 2022).

Family	Taxa	Stations				Total	%
		1	2	3	4		
Centropomidae	*Lates niloticus* (Linnaeus, 1758)	30	16	19	0	65	0.95
Cyprinidae	*Labeo coubie* (uppel, 1832)	431	538	472	30	1471	21.47
Characidae	*Hydrocynus foskali* (Cuvier, 1819)	52	80	73	0	205	2.99
	Alestes macrolepilotus (Valenciene,1846)	53	49	46	0	148	2.16
	Alestes baremose (Leach, 1825)	59	73	98	0	230	3.36
Citharinidae	*Citharinus citharus* (Geoffrey, 1809)	51	60	38	2	151	2.20
Gymnarchidae	*Gymnarchus niloticus* (Cuvier, 1829)	2	7	2	0	11	0.16
Malapteruridae	*Malaperurus electrical* (Gmeli, 1789)	7	8	2	0	17	0.25
Schilbeidae	*Eutropius niloticus* (Gunther, 1864)	17	11	21	0	49	0.72
Bagridae	*Bagrus bayad* (Forska, 1775)	65	60	51	2	178	2.60
	Bagrus docmac (forskal, 1775)	0	13	19	0	32	0.47
Claroteidae	*Clarotes laticeps* (Ruppel,1829)	27	48	48	1	124	1.81
	Auchenoglanis biscutatus (Ruppel, 1829)	0	27	0	0	27	0.39
Claridae	*Clarias gariepinus* (Burchell, 1822)	76	84	44	27	231	3.37
Cichlidae	*Tilapia zilli* (Gerval,1848)	12	24	0	0	36	0.53
	Oreochromis niloticus (Linnaeus, 1758)	264	275	196	11	746	10.89
	Sarotherodon (Linnaeus, 1758)	34	15	23	0	72	1.05
Mormyridae	*Mormyrus rume* (Cuvies, 1846)	38	69	57	7	171	2.50
	Hyperopisus bebe (Gunther, 1886)	11	11	11	11	44	0.64
	Mormyrops deliciousus (Leach, 1818)	2	7	3	0	12	0.18
Osteoglossidae	*Heterotis niloticus* (Cuvier,1829)	5	3	9	3	20	0.29
Mugilidae	*Mugil cephalus* (Lacepede, 1803)	198	170	179	0	547	7.80
Potamotrygonidae	*Stingrays* (Valenciennes,1846)	7	3	8	2	20	0.29
Clupeidae	*Cynothrissa mento* (Johnels, 1954)	87	54	93	0	234	3.42
Mochokidae	*Synodontis batensoda* (Daget, 1954)	645	934	383	47	2009	29.33
Total		2173	2639	1895	143	6,850	100.0

Diversity indices of fish species in Downstream Jebba Dam.

Table 2 shows the diversity indices of fish species downstream of Jebba Dam. The highest species richness (25) was recorded at station 2, followed by stations 1 and 3 with 23 species, and then station 4 with 11 species. The number of individuals was highest in station 2 (2639), followed by station 1, with (2173) species, then station 3 (1895), and (143) species at station 4. Station 2 had the highest margalef index (3.05), stations 1 and 3 were almost the same in species composition (2.86) and (2.92), respectively, while station 4 had the least margalef index (2.02). The Shannon-Weiner index was highest in station 3 (4.01), followed by station 1 (3.39), while station 2 was (3.13), and the lowest was in station 4 (2.50). Simpson´s dominance was recorded highest in station 2 (0.19), than station 1 with (0.16), while station 3 was (0.13), and the lowest was recorded at station 4 with (0.12). The Evenness index indicated that no significant difference between stations 1 and 2 when ($p>0.05$) (0.38 and 0.36). The highest evenness was in station 3 (4.01), while station 4 was the least even (2.50).

Table 2: Diversity indices of fishes in downstream Jebba Dam.

Indices	Station 1	Station 2	Station 3	Station 4
Taxa (Species)	23	25	23	11
Number of individual fish	2173	2639	1895	143
Simpson dominance	0.16	0.19	0.13	0.12
Shannon index (H)	3.39	3.13	4.01	2.5
Evenness (E)	0.38	0.36	0.45	0.28
Margalef's index (D)	2.86	3.05	2.92	2.02

Morphometrics of selected fish species in downstream Jebba dam.

Table 3 shows the length-weight relationship and condition factor of dominant fish species in the sampled stations of Downstream Jebba Dam. The length-weight relationship (r) of all the sampled fish from Downstream Jebba dam ranged from 0.018 in *Clarotes laticeps* to 0.215 in *Labeo coubie*. The Length-Weight relationship (LWR) of the dominant fish species ranged between 0.0018-0.215, and the observed "*b*" value was <3; thus the allometric growth was negative In term of mean condition factor (K of the dominant fish species of Downstream Jebba Dam, *Cynothrissa mento*, had the highest with 10.09, followed by *Oreochromis niloticus* (9.82), *Mugil cephalus* (9.02) *Labeo coubie* (3.72), *Bagrus bayad* (0.90), *Alestes macrolepidotus* (0.52), *Clarote laticeps* (0.31), *Momyrus rume* (0.26), *Clarias gariepinus* (0.19) and *Citharinus citharus* (0.16). The high condition factor (>1) observed in some fish indicates that these fish species were physiologically stable and successful well, while those with less than (< 1) mean value implied that it was physiologically unstable, as showed in some species.

Table 3: Mean Condition factors (K) of some Dominant fish species in Downstream Jebba dam.

Fish Species	Mean condition (K) factors	Range	Length-Weight Relationship
Momyrus rume	0.26	0.18-0.46	0.025
Citharinus citharus	0.16	0.25-0.37	0.022
Labeo coubie	3.72	1.25-10.94	0.215
Bagrus bayad	0.90	1.67-1.92	0.026
Clarias gariepinus	0.19	0.17-0.4	0.034
Alestes macrolepido	0.5	0.52-0.90	0.021
Cynothrissa mento	10.09	7.87-16.80	0.034
Clarotes laticeps	0.31	0.0-1.25	0.018
Oreochromis niloticus	9.82	0.58-16.56	0.109
Mugil cephalus	9.02	6.40-18.45	0.080

DISCUSSION

The results of this study show the abundance of fish in downstream Jebba Dam, which could be due to good water quality, which enhances good breeding as most fish species prefer less disturbed water for spawning. A total of 6,850 fish specimens from 25 species and 17 families were identified from the four sampled stations of Downstream Jebba Dam. In this study, the fish population decreases downward the sampling station 4, which has high anthropogenic activities. Additionally, more fish were captured in this study when compared to the finding of Agbugui *et al.* (2019), who reported 706 fish from 18 families and 35 species at the three sites at River Niger in Agenebode, Edo state. Okomoda *et al.* (2012) also report the presence of 13 families and 28 species in the Lower River Niger near Idah in Kogi State.

Additionally, Also Lawal *et al.* (2023) reported a total of 8273 fish from Mairua Reservoir Water, Funtua, Katsina State, North-Western Nigeria. Oladipo *et al.* (2021) also reported the patterns of ichthyofaunal diversity and distribution across the Jebba Hydro-Electric Power dam and reported a total of 9605 freshwater fishes were recorded during the sampling period. Abiodun and Odunze (2011) noted that Jebba Lake, Nigeria, is home to 51 species from 12 families in their findings. The variation in the number of families and species found in a certain river, as well as in other rivers, can be ascribed to seasonal variations, environmental shifts, and human activities that lead to fish migration and relocation from one place to another (Sikoki *et al.,* 2008). At every sampling station, *Synodontis batensoda* was the most dominant fish, and this shows that the species is tolerant of environmental conditions such as low temperature, conductivity, and pH, as well as water pollution (Wubie *et al.,* (2017). Mochokidae and Cichlidae were the most abundant family in this study. Oladipo *et al.* (2021) earlier reported the abundance of these families in the Jebba Hydro-Electric Power dam. Also, Abiodun and John (2017) reported the abundance of Mochokidae and Cichlidae lower River Niger basin. These families' supremacy may be related to their great degree of environmental adaptability and prodigious breeding skills (Mustapha, 2010).

The abundance of the family Cyprinidae in this study is consistent with the findings of Rusmilyausari *et al.* (2021), who observed a similar abundance in the Martapura River in South Kalimantan, Indonesia. According to Buwono *et al.* (2017), there are comparatively many species in the freshwater Cyprinidae family. In line with the assertion made by Sulaiman *et al.* (2018), 40 of the 104 freshwater species discovered in Brunei Darussalam are members of the Cyprinidae family. Comparably, Xing *et al.* (2016) also reported the abundance of the Cyprinidae family in the Ganjiang River. *Tilapia zilli, Oreochromis niloticus, and Sarotherodon* sp are the representatives of the Cichlidae family in this study. The results of this study, which focused on the dominance of cichlids, in particular *Oreochromis niloticus,* are consistent with many other findings from Nigeria. Nazeef *et al.* (2021) studied the biodiversity of fish species in the Dadin-Kowa reservoir in Gombe State and reported the presence of the chichlidae family. Also, chichlidae abundance has been reported by many studies in Nigeria (Solomon *et al.,* 2017; Dienye *et al.,* 2018; Pius *et al.,* 2020; Abdulkarim *et al.,* 2020; Olopade, 2020; Oladipo *et al.,* 2021; Omoike, 2021; Lawal *et al.,* 2023) who all documented the dominance of this species. The dominance of cichlid fish can be attributed to several noteworthy features, such as their rapid rate of proliferation and their status as the second most varied family of freshwater fish (Seehausen, 2015). In the freshwater ecology of Nigeria, cichlids have been observed to be the most abundant group (Mustapha, 2010). Comparably, it has been reported that the lower River Niger basin is home to large populations of Cichlidae and Mochokidae (Atile *et al.,* 2016; Abiodun and John, 2017). These families' supremacy may be related to their great degree of environmental adaptability and prodigious breeding skills (Mustapha, 2010). The Characidae family represented prominent species like *Alestes baremose, Hydrocynus foskali, and Alestes macrolepilotus* were also abundant in this study. This exceptional abundance is explained by the species' adaptability to a variety of feeding habits, their body size in relation to speed of growth, fecundity level, and availability of food sources (Pius *et al.,* 2020).

Mormyridae abundance was low when compared to the report of Abiodun and John (2017), who reported the abundance of this group in Lower River Niger, Idah, Kogi State. *Malapterurus electricus* is the only representative of the family Malapteruridae. The presence of this family conforms to the report of Mo *et al.* (2019) and in contrast with the reports of Essien Ibok (2020), who reported their absent in their findings. *Potamotrygon motoro* was the only taxon that represented the family Potamotrygonidae which account for 0.29% of the composition. *Eutropius niloticus,* belonging to the family Schilbidae was also documented in this study. *Clarias gariepinus* is the only representative of the Claridae family found in all of the studied stations. Nazeef *et al.* (2021) also reported their presence in all the sampled stations of the Dadin-Kowa reservoir. *Gymnarchus niloticus*, the only taxa represented in the family Gymnarchidae, was the least abundant group in this study. This is in contrast to the findings of Agbugui *et al.* (2019), who reported that the family Gymnachidae was the most abundant, with 8.49% of only specie Gymnarchus niloticus in River Niger at Agenebode, Edo State, Nigeria.

The chosen fish species' length-weight correlation coefficient (r=0.71), which was recorded at the downstream Jabba Dam, revealed a substantial positive connection between length and weight, indicating that weight increases as length increases. Positive correlations were also reported by Solomon *et al.* (2012) and Benedict *et al.* (2009) in Cross River wetlands. Similarly, Leonard *et al.* (2011) reported a good correlation (r = 0.874; 0.973) between Buyo and Ayame Reservoirs and Ezekiel and Abowei (2014) in the Niger Delta's Amassoma flood plain. The variances in the values could be caused by differences in the environment, location, time of year, and the sizes and numbers of species sampled. The positive association demonstrated that the growth pattern did not override the significant link between fish weight and length. These observations may also be the result of variations in the quantity and quality of fish present, food availability, and water quality. The Length-Weight relationship (LWR) 0.022-0.035 data for fish species indicate that "b" is less than three for every species. A negative allometric growth pattern was seen in this study. Abowei and Hart (2014) also reported negative growth patterns of some fish species in the lower River Nun in the Niger Delta. Negative allometric growth was also reported by Olowo et al. (2022) from fish species from the Ovia River, Edo State, Nigeria. The study's condition factors varied according to the species: *Citharinus citharus* had the lowest condition factor (0.16), while *Cynothrissa mento* had the greatest condition factor (10.09). Olowo *et al.* (2022) reported positive condition factors from fish species from the Ovia River, Edo State, Nigeria. The variations may result from variations in the physical and chemical characteristics of the environments, the plant and animal populations, the weight of the individual species studied, the time of the sampling, and the availability of food.

CONCLUSION

The fish species found downstream of the Jabba Dam show a total of 6,850 fish from 17 families, and 25 species were seen throughout the study period, indicating a less perturbed water body, and the river continues to provide good habitat for the development and preservation of fish populations. Also, the length-weight relationship of a few dominating species, such as *Alestes macrolepilotus, Mugil cephalus, Cynothrissa mento, Labeo coubie,* and *Synodontis batensoda,* had a strong positive link, as indicated by the correlation coefficient (r) value, but the regression coefficient (b) value indicated a negative allometric growth rate. The study also found that the condition factor of a few dominant fish species was physiologically stable and successful in the aquatic environment, with the exception of the species that showed values below 1, which indicates that they are not physiologically stable. Overall, the studied river shows a medium fish production potential in the studied river.

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