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FISH SPECIES COMPOSITION AND DIVERSITY OF DADIN-KOWA RESERVOIR GOMBE STATE, NIGERIA

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ABSTRACT

Climatic characteristics affect water quality and quantity and this inevitably affects biodiversity. The study was conducted for eight months to determine the composition and diversity of fish species in Dadin Kowa Reservoir. Fish samples were taken at three stations using conventional fishing gear. The fish samples were identified using standard description keys. The Shannon Weiner Diversity Index was used to determine the diversity of fish species in the reservoir. A one-way analysis of variance (ANOVA) was used to test for significant monthly variations in fish species, and Duncan's multiple range test (DMRT) was used to separate the means where significant differences existed. Thirty (30) fish species belonging to eleven (11) families were identified from a total of 690 fish samples. The Mormyridae family had the most species (6), followed by the Mochokidae family (5), then the Alestidae, Cyprinidae, Clariidae, and Claroteidae families, while the Malapteruridae, Polypteridae, and Schilbeidae families had one species each. The Mormyridae family had the highest proportion of species with 20.0% fish, followed by Mochokidae with 16.7%. The families Malapteruridae, Polypteridae and Schilbeidae had the lowest catches with 3.3%. The genus Petrocephalus had the highest proportion of fish with 18.99%, followed by Heterobranchus with 16.23%. The genus Malapterurus was the least caught with 0.72% fish. Of the total fish species examined, *Mormyrops anguilloides*, *Clarias anguillaris*, and *Schilbe mystus* had 14.5%, 8.7%, and 8.6% of the fish composition, respectively. *Labeo senegalensis* and *Synodontis budgetti* had 6.9% and 5.8%, respectively. While the remaining fish species had a percentage occurrence of less than 5%. There was significant variation ($P \leq 0.05$) in the number of fish species sampled monthly in the reservoir. The highest diversity index of 2,056 was found in the family Cyprinidae. The lowest index value of 1.32 was obtained in the family Claroteidae. The level of family uniformity was lowest in the Alestidae (0.83) and highest in the Cyprinidae (0.98). The genera Hyperopisus, Mormyrops, and Malapterurus had the lowest indices, while Petrocephalus, Clarias, Barbus, and Oreochromis had the most fish species. The study revealed a rich fish composition with important economic species and a highly diversified fish community structure in the reservoir.

Keywords: Dadin-Kowa Reservoir, Diversity, Fish, Composition.

INTRODUCTION

The rapid urbanization of many towns and cities across the world necessitate the construction of reservoirs to supply these towns with portable pipe borne water. Dadin-Kowa reservoir is one of such water bodies in Gombe State that supplies water to Dadin-Kowa, Yamaltu Deba Local Government Area and other parts of Gombe State. These reservoirs apart from their primary function also have secondary uses for fisheries and irrigation of farmlands. The diversity of fish mainly depends on the biotic factors and types of ecosystems (Nanda and Tiwari, 2001). Climatic characteristics affect water quality and

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quantity and this inevitably affects biodiversity. Human activities, population growth, oil production and exploration have been found to be changing the ecology of inland waters in Nigeria (Keremah *et al*., 2014). Nigerian inland waters are mainly used by fishermen for fishing (Adaka *et al*., 2014). Fishery resources in Nigeria are declining due to overfishing and poor coastal water management (Lawson and Olusanya, 2010). There are numerous reports of the accumulation and diversity of fish in the Nigerian freshwater ecosystem. The fish fauna of Tagwai Lake Minna, Nigeria (Ayanwale *et al*., 2013) comprised 8 species belonging to 7 genera and 6 families, with two cichlid species; *Tilapia zilli* and S*arotherodon galilaeus* (Cichlidae), which are the most abundant, account for 33.01% and 26.06% of the total catch, respectively. David *et al*. (2015) reported that 57 species were observed in 16 fish families at Kiri Lake and 40 species in 16 fish families at Gyawana Lake, Adamawa State, Nigeria. Also, Dankishiya (2012) reported that the Cichlidae family was the most dominant family by number (72.79%) and weight (34.72%). Thirty-eight (38) fish species belonging to seventeen (17) families were recorded during the study. The fish of the Hadejia-Nguru Wetlands were dominated by members of the families Cichlidae and Mormyridae, each containing nine species of fish. The family Characidae has three species, the families Distichodontidae, Bagridae, Clariidae and Malapteruridae had two species each (Abubakar *et al*., 2015). Anwana and Nwosu (2014) observed four dominant families of fish species in three lakes (Adigbe, Efi and Obaa) in southwestern Nigeria as Mochokidae, Citharinidae, Cichlidae and Channidae. Mochokidae was the most diverse with six (6) representative species. Lawson and Olusanya (2014) also reported that the family Mochokidae (Synodontis membranaceous) has the highest numbers from Lake Esiribi from the same geographic region. Fish communities differ across bodies of water, so site-specific management policy information is important for fisheries biology and conservation of fish communities. Therefore, for the sustainability of Nigerian fisheries resources, adequate knowledge of the species composition, diversity and relative abundance of its waters must be understood and vigorously pursued (Lawson and Olusanya, 2014). Information on the current composition and diversity of fish species in the Dadin Kowa reservoir is required for proper documentation and is critical to the sustainable management of the reservoir.

MATERIALS AND METHODS

Study Area

Dadin-Kowa Reservoir is located 5 km North of Dadin-Kowa village about 37 km from Gombe Town, along Gombe - Biu Road in Yamaltu Deba Local Government Area of Gombe State in the North East of Nigeria. The area lies within Longitudes 11° 30′ E and 11° 32′ E, and Latitudes 10 ° 17′ and 10° 18′ N (UBRDA, 1980) (Figure 1). The reservoir was completed by the Federal Government in 1984 with damming of River Gongola. The reservoir had a capacity of 800 million cubic metres of water and a surface area of 30, 000 hectares (William, 2001). The surrounding settlements of Dadin-Kowa mainly depend on agriculture as major source of livelihood. The flood plains known as Fadama lands, as a result of the Dadin-Kowa River, a tributary to river Benue makes both ground water and surface water available and accessible. It is basically an agrarian society that produces agricultural products such as sorghum, millet, cotton, vegetables, rice, maize, groundnut, banbara-nut, as well as fruits and

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engage in activities as weaving, fishing, hunting among others (Ahmed and Philip, 2012).

Sampling Stations

Three sampling stations were selected in the reservoir. Station A was the area around the water entry into the reservoir, with the water movement being relatively obvious due to the intrusion of a large volume of water compared to other parts of the reservoir. Station B was the area around the central part of the reservoir with no obvious signs of water movement. Station C was the part of the reservoir where the water is shallower and characterized by relatively high anthropogenic activity.

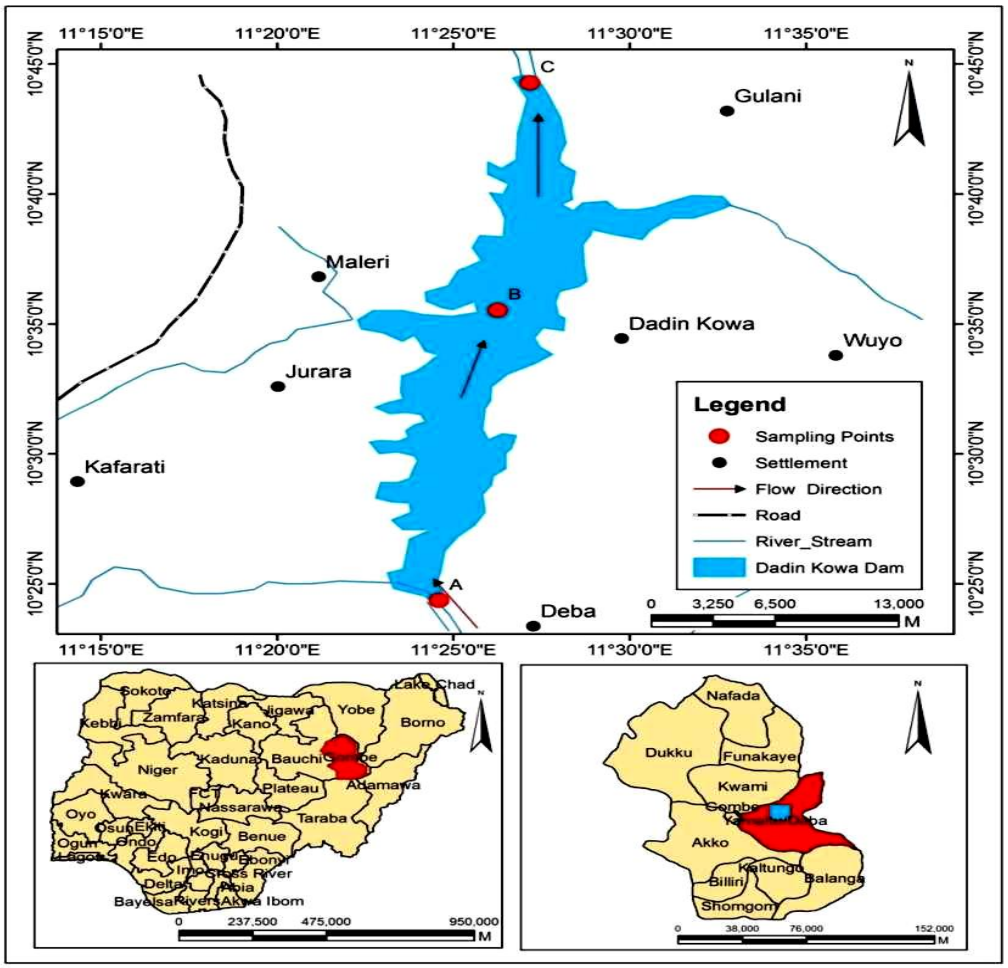

Figure 1: Map showing Dadin-Kowa reservoir and the sampling Stations (A, B and C)

Fish Sampling and Identification

The commercial catches of the fishermen operating in the reservoir (upstream and downstream) were assessed. The fishing gears employed by the fishermen in Dadin-Kowa reservoir included cast nets, gillnets among others. The fish samples obtained from the fishermen were identified using two methods; firstly, fishermen identification in the local language was done and secondly the fishes were transported to the Hatchery Unit/Laboratory, Department of Biology, Ahmadu Bello University Zaria in an ice- box where they were identified up

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to family and generic levels using description keys of Balogun (2006) and Suleiman (2016). Fish identification was done to species level using description keys of Holden and Reed (1992) and Babatunde and Raji (1998), in line with Fish Base.

Determination of Fish Diversity

Diversity of the fish fauna was determined using the Shannon Wiener (Shannon Wiener, 1963) index given by the formula:

$$H = -\sum_{i=1}^{k} p_i \log p_i$$

Where:

H = Shannon Wiener diversity index.

i = Count denoting the ith species ranging from 1 n.

pi = Proportion that the ith species represents in terms of number of Individuals with respect to the total number of individuals.

The Simpson's index (Simpson, 1949) was used to calculate both species richness and an evenness of abundance among the fish species sampled from the reservoir. The formula is given by:

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

Where:

D = Simpson's index

n_i = the total number of organisms of each individual species

N = the total number of organisms of all species.

Data Analysis

One-Way Analysis of Variance (ANOVA) was used to test for significant differences in monthly variation in fish species composition in the reservoir and Duncan's Multiple Range Test (DMRT) was used to separate the means where significant difference existed. Statistics significant difference was set at $P \leq 0.05$.

RESULTS

The results of fish species identified was presented in Table 1. A total of thirty (30) fish species representing eleven (11) families were identified. The results showed that family Mormyridae had the highest number of species (6) followed by the family Mochokidae (5) then the families Alestidae, Cyprinidae, Clariidae and Claroteidae having three (3) species each, followed by the families Bagridae and Cichlidae while the families Malapteruridae, Polypteridae and Schilbeidae had one species each. Of the eleven fish families recorded, 4 (36.4%) were scaled fish species while the other 7 (63.6%) were non-scaled species (Table 1). The highest percentage of 20.0% occurred in the family Mormyridae. The family Mochokidae had 16.7%. The families Alestidae, Cyprinidae, Claroteidae and Clariidae had 10.0% each, with the families; Cichlidae and Bagridae composed of 6.7% each. Malapteruridae, Polypteridae and Schilbeidae represented 3.3% each of the species.

Table 2 shows the percentage composition of fish species identified in Dadin-Kowa reservoir. Out of the total of 690 fish species identified, *Mormyrops anguilloides, Clarias anguillaris* and *Schilbe mystus* represented 14.5%, 8.7% and 8.6%, respectively of the total fish species identified. *Labeo senegalensis* and *Synodontis budgetti* made up 6.9% and 5.8% respectively. While the remaining fish species represented less than 5% of the total fish species.

The monthly variation in fish species in the reservoir showed that there was significant

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variation ($P \leq 0.05$) in the number of fish species sampled monthly. February and March had higher number of fish species (26) and the lowest (15) was obtained in December (Figure 2). The months of February, March and April showed significant differences ($P \leq 0.05$) with October, November and December. There were significant differences between March with February and May, April and May and also December with January. The highest catch was in the family Bagridae with 167 fish followed by Claridae with 112. The family Malapteruridae with 5 individuals had the least catch (Table 2).

Table 1: Fish composition of fish families identified in Dadin-Kowa Reservoir

Family	Percentage (%)	Genus	Species
Scaled Fishes			
Mormyridae	20.0	*Hyperopisus*	*Hyperopsus bebe* (Lacepede, 1803)
		Mormyrus	*Mormyrus rume* (Valenciennes, 1847)
		Mormyrus	*Mormyrus hasselguistii* (Pellegrin, 1926)
			Mormyrus macrophthalmus (Günther, 1866)
		Mormyrops	*Mormyrops anguilloides* (Linnaeus, 1758)
		Petrocephalus	*Petrocephalus ansorgii* (Boulenger, 1903)
Cyprinidae	10.0	*Barbus*	*Barbus occidentalis* (Boulenger, 1911)
		Labeo	*Labeo senegalensis* (Valenciennes, 1842)
			Labeo pseudocoubie (Blache and Miton, 1960)
Cichlidae	6.7	*Coptodon*	*Tilapia zilli* (Gervais, 1848)
		Oreochromis	*Oreochromis niloticus* (Linnaeus, 1758)
Alestidae	10.0	*Alestes*	*Brycinus macrolepidotus* (Valenciennes, 1850)
		Hydrocynus	*Alestes nurse* (Pellegrin, 1935)
			Hydrocynus vittatus (Castelnau, 1861)
Non-Scaled Fishes			
Clariidae	10.0	*Clarias*	*Clarias anguillaris* (Linnaeus, 1758)
			Clarias gariepinus (Buechell, 1822)
		Heterobranchus	*Heterobranchus bidorsalis* (Geoffrey St. Hilaire, 1809)
Claroteidae	10.0	*Chrysichthys*	*Chrysichthys nigrodigitatus* (Lacepède, 1803)
			Chrysichthys auratus longifilis (Geoffroy
		Auchenoglanis	Saint-Hilaire, 1809)
			Auchenoglanis occidentalis (Valenciennes, 1840)
Bagridae	6.7	*Bagrus*	*Bagrus bajad* (Forsskal, 1775)
			Bagrus docmak (Forsskål, 1775)
Mochokidae	16.7	*Synodontis*	*Synodontis nigrita* (Valenciennes, 1840.)
			Synodontis melanoptera (Rüppell, 1832)
			Synodontis budgetti (Roman, 1966)
			Synodontis clarias (Linnaeus, 1758)
			Synodontis vermiculata (Daget, 1954)
Polypteridae	3.3	*Polypterus*	*Polypterus senegalus* (Arnoult,1964)
Schilbedae	3.3	*Schilbe*	*Schilbe mystus* (Linnaeus, 1758)
Malapteruridae	3.3	*Malapterurus*	*Malapterurus minjiriya* (Sagua, 1987)

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Table 2: Percentage composition of fish species identified in Dadin-Kowa Reservoir

Fish species	Number identified	Percentage (%)
Hyperopisus bebe	10	1.4
Mormyrus rume	20	2.9
Mormyrus hasselguistti	10	1.4
Marcusenius macrophthalmus	6	0.9
Mormyrops anguilloides	100	14.5
Petrocephelus ansorgii	11	1.6
Bagrus bajad	20	2.9
Bagrus docmak	8	1.2
Chrysichthys nigrodigitatus	7	1.0
Chrysichthys auratus longifilis	21	3.0
Auchenogranis occidentalis	8	1.2
Clarias anguillaris	60	8.7
Clarias gariepinus	20	2.9
Heterobranchus bidorsalis	32	4.6
Alestes nurse	14	2.0
Brycinus macrolepidotus	13	1.9
Hydrocynus vittatus	10	1.4
Oreochromis niloticus	29	4.2
Tilapia zillii	30	4.3
Barbus occidentalis	9	1.3
Labeo senegalus	48	6.9
Labeo pseudocoubie	15	2.2
Synodontis nigrita	30	4.3
Synodontis melanopterus	20	2.9
Synodontis budgetti	40	5.8
Synodontis clarias	18	2.6
Synodontis vermiculata	7	1.0
Polypterus senegalus	10	1.4
Schilbe mytus	59	8.6
Malapterurus minjiriya	5	0.7
TOTAL	**690**	**100**

Of the total of 690 fish sampled, the highest number of 131 fish belonged to the genus *Petrocephalus*, followed by *Heterobranchus* with 112. The least catch was in the genus *Malapterurus* with 5 (Table 3). The Shannon Weiner Diversity Index (H) and evenness of fish genera from the reservoir is represented in Table 3. The highest diversity index of 1.99 was in the genus *Clarias*. The least index value of 1.00 was obtained in the genus *Hydrocynus*. The degree of evenness of the families was lowest (0.83) in Alestidae and highest (0.98) in Cyprinidae. The family Malapteruridae with the least individuals had the least dominance while the family Cichlidae had the highest value of 0.19. The genera *Hyperopisus*, *Mormyrops* and *Malapterurus* had the lowest indices while *Petrocephalus, Clarias, Barbus* and *Oreochromis* had relatively high Shannon Weiner Indices (Table 3).

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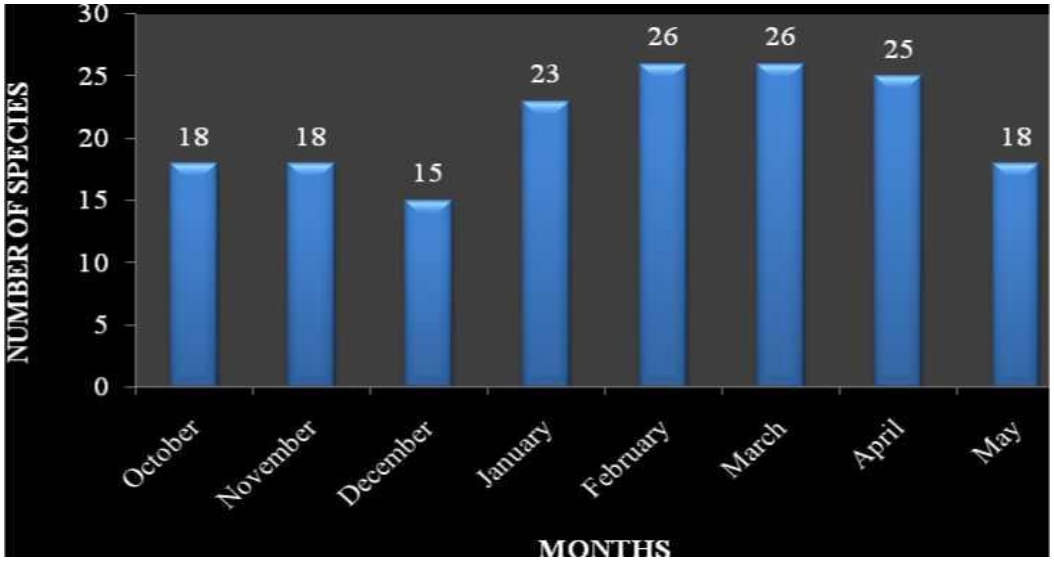

Figure 2: Monthly variation in number of fish species present in Dadin-Kowa Reservoir

Table 3: Shannon Weiner Diversity Index (H) and evenness of fish genera in Dadin-Kowa Reservoir

Fish Genus	Total	%	Dominance	Simpson Diversity Index	Shannon Diversity Index	Evenness
Hyperopisus	10	1.45	0.30	0.70	1.28	0.90
Mormyrus	30	4.35	0.16	0.84	1.87	0.93
Mormyrops	6	0.87	0.28	0.72	1.33	0.95
Petrocephalus	131	18.99	0.15	0.85	1.98	0.91
Bagrus	15	2.17	0.23	0.77	1.55	0.94
Chrysichthys	21	3.04	0.21	0.79	1.66	0.88
Auchenoglanis	8	1.16	0.28	0.72	1.32	0.94
Clarias	112	16.23	0.15	0.85	1.99	0.92
Heterobranchus	37	5.36	0.19	0.82	1.76	0.83
Brycinus	59	8.55	0.19	0.81	1.81	0.87
Hydrocynus	9	1.30	0.41	0.59	1.00	0.90
Oreochromis	48	6.96	0.15	0.85	1.91	0.97
Barbus	65	9.42	0.15	0.85	1.98	0.91
Labeo	40	5.80	0.19	0.82	1.74	0.95
Synodontis	25	3.62	0.23	0.77	1.60	0.83
Polypterus	10	1.45	0.22	0.78	1.56	0.95
Schilbe	59	8.55	0.16	0.84	1.88	0.93
Malapterurus	5	0.72	0.28	0.72	1.33	0.95
Total	**690**					

DISCUSSION

The fish composition of the Dadin-Kowa reservoir included a total of thirty (30) fish species representing eleven (11) families sampled and identified during the study period. These species accounted for 13% of the estimated 230 fish species in Nigeria's rivers reported by Ita (1993). Reports by Odo *et al*. (2009) estimated 52 fish species in 17 families in the Anambra River, while 37 fish species in 21 families from Badagry Lagoon were estimated by Soyinka *et al*. (2010) were

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estimated. David *et al*. (2015) reported 21 species in 10 families in Lake Kiri. Adaka *et al*. (2014) reported an estimate of 25 fish species, 15 genera, 21 families and six orders from the Oramiri-Ukwa River in southeastern Nigeria. Uttah (2012) also reported 70 fish species in 31 families in Ikot Abasi, Nigeria. Fluctuations in the composition of fish species in Nigerian inland waters have been documented. Jamu and Ayinla (2003) reported that environmental degradation and poor management of fish resources are responsible for the decline in fish yield in Nigerian inland waters. Gulland (1991) attributed differences in catch ability to the type of gear used, weather or other environmental conditions, and timing of catch.

The dominance of the six (6) species family Mormyridae in the Dadin-Kowa Reservoir may be due to ecological resources in the reservoir favoring this species. Modifications to the Mormyridae's mouthparts make feeding easier for small invertebrates buried in muddy substrates. Fish, particularly tilapias and crustaceans, are the diet of Mormyridae, while the juveniles of the family prey on benthic invertebrates, mainly aquatic insects (Kouamela *et al*., 2000). Nazeef and Abubakar (2013) reported that the Mormyridae family had the highest number of three (3) species in the Dadin Kowa reservoir. The family Mormyridae has also been reported as the dominant taxon with nine (9) species in the Nguru Wetlands of Nigeria (Abubakar *et al*., 2015). However, this report contradicts the results of Balogun (2005), Dankishiya and Abdulrahman (2007), Mustapha (2008) and Dankishiya *et al*. (2013) who identified the cichlid family as the most dominant in a series of reservoirs in Nigeria. The dominance of cichlids is attributed to the high breeding ability of family members (Ataguba *et al*., 2014).

It has been reported that the fish families found in Dadin Kowa Reservoir during the study were found in the same and similar waters across Nigeria (Ita, 1993; Abubakar *et al*. 2015; Suleiman, 2015). That the families Malapteruridae, Polypteridae and Schilbeidae are the rarest in the reservoir could be the result of a tight tolerance for most factors. The highest catch in February could be associated with low water temperature due to harmattan and low water levels in the reservoir. The Bagridae family was more susceptible to being caught in the reservoir, while Malapteruridae could be least associated with the behavior of the species in these finds or the type of fishing gear used. Malapteruridae is generally found among rocks or roots in murky or black waters with low visibility (Ng, 2000). The range of Shannon Weiner Diversity Index (H) values in this study indicates good diversity of fish families in the reservoir. H values ranging from 1.809 to 2.015 have been reported for three tributaries of the Ore River (Lawson and Olusanya, 2010).

The range of Shannon Weiner values obtained in the study was similar to the range of 1.81 to 2.37 reported by Nazeef and Abubakar (2013) in the same reservoir. Although the genera Barbus (0.4) and Clarias (0.15) had the highest and lowest dominance scores, a genera uniformity scores close to 1.0 indicated an even distribution of genera in the reservoir. The low degree of uniformity observed in the family Alestidae indicates few species in the family. Cyprinidae with the highest uniformity score (0.98) indicated the high density of the family. The highest diversity in the genus Clarias and the lowest in Hydrocynus could be due to their respective low and high dominance in the reservoir. The diversity of species within a natural community reflects in part the diversity of the physical environment. Smith (1966) found that the greater the variation in

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the physical environment, the more numerous the species, since more numerous microhabitats are available and more niches can be occupied. Differences in fish diversity have been attributed to water quality, diet composition and exploitation (David *et al*., 2015).

CONCLUSION

Thirty (30) fish species belonging to eleven (11) families were identified from a total of 690 fish samples. The Mormyridae family had the most species (6), followed by the Mochokidae family (5), then the Alestidae, Cyprinidae, Clariidae, and Claroteidae families, while the Malapteruridae, Polypteridae, and Schilbeidae families had one species each. The Mormyridae family had the highest proportion of species with 20.0% fish, while the families Malapteruridae, Polypteridae and Schilbeidae had the lowest catches with 3.3%. The genus Petrocephalus had the highest proportion of fish with 18.99%, while the genus Malapterurus was the least caught with 0.72% fish. The highest diversity index of 2,056 was found in the family Cyprinidae. The lowest index value of 1.32 was obtained in the family Claroteidae. The study revealed a rich fish composition with important economic species and a highly diversified fish community structure in the reservoir. However, there is a need to maintain and improve management of the reservoir for better and more diverse fish production.

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