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Biodiversity and condition factor of fish species from Challawa Gorge Dam

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Abstract
An assessment of the biodiversity and condition factor (K) of fish species from Challawa Gorge Dam was carried out over a period of six months (March-August, 2017). A total of ten (10) species representing nine (9) families were identified under the families Bagridae, Alestidae, Cichlidae, Claridae, Claroteidae, Latidae, Mochokidae, Mormyridae and Schilbeidae. Families Cichlidae and Mormyridae had the highest representation in terms of species and number of individuals. Assessment of the condition factor (K) showed that the family Mormyridae had the highest K values, followed by family Cichlidae. Schilbeidae had the least K values. However, the entire K value showed a 50% below and 50% average condition factors of fish. The dam has a rich ichthyofauna complex. Effective exploitation measures should be used to deter the menace of local extinction in the near future.

Keywords: Biodiversity, condition factor, Challawa Gorge Dam

1. Introduction
The African fish species diversities were observed by many researchers [1-3]. Fish is an inexpensive source of protein and an important cash crop in many regions of the world [4].
Nigeria is endowed with numerous water confinements suitable for the growth of fish which account for number one in West Africa in terms of abundance [5]. Nigeria's populations live around coastal and riverine environment with diverse species of fish which serve as a source of food and income [6].
The natural aquatic systems have witnessed changes in stock diversity and abundance, genetic structure and age composition of stocks resulting from structural changes in habitat, food composition and uncontrolled exploitation [2], Fisheries resources are fast reducing in Nigeria due to over exploitation and inadequate management of her inland waters, an adequate knowledge of species composition, relative abundance of her water bodies must be understood and actively pursued for the sustainability of these resources [7].
The fish species diversity is simply a measure of the number of fish species that constitute a biologic aquatic community, which is considered to be one of the most important aspects of community organization and structure [5]. Fish species richness and relative abundance describe key elements of biodiversity [3]. The fish diversity which is currently recognized worldwide shows 25,000 species, of which 10,000 species are found in freshwater ecosystems. Specialists have estimated that at least 5,000 await discovery. Fish exhibits the greatest biodiversity among the vertebrates, with approximately 25,000 species, comprising about known vertebrate species [6]. According to Darwall and Vie (2005), freshwater fishes are one of the most endangered taxonomic groups due to their high sensitivity to quantitative and qualitative alterations of aquatic habitats, as a consequence; they are often used as bioindicators for the assessment of water quality, flow regime, river network and connectivity [8]. The management of fish biodiversity and associated habitats is a huge task [3].
An estimation of the species composition is important to the study of a stock's dynamics and in the management of species. Densities indices of stocks are often used in stock assessment in multi-species assessment, ecosystem studies and in studies of economically and environmentally important fish species [9].
Abubakar and Ja'afar (2015) identified 26 species representing 14 families in Dadin-kowa dam. Also 15 species were identified representing 11 families from the same dam by Nazeef and Abubakar (2013). Eight (8) families were identified from three lakes (Ajiwa, Zobe and

Jibya) of Katsina State [9]. A survey of the artisanal fisheries of Kontagora Reservoir was conducted, using statistical frame survey and catch assessment survey; the survey revealed five (5) fish families made up seven fish species [10].

Odo *et al.* (2009) reported an estimated fifty two (52) fish species belonging to seventeen (17) families from Anambra River, Nigeria. Also twenty-seven (27) species belonging to 13 families were identified from Asejire Lake [2].

The outcomes of fishery sector and its resources of Nigeria are not confined to considerable economic importance, but also contribute to national food security, employment in rural areas and a means of recreation. Fish stock diversities are directly dependent on the quality and quantity of water resources in the country [11].

The condition factor (K) as applicable to fish growth pattern is the condition of general wellbeing of fish as well as an indicator of physiological state of the fish in relation to its welfare and also provides information when comparing two populations living in certain feeding density, climate and other conditions. Hence, the condition factor *K* value is calculated from the weight and length, and can be used to estimate changes in nutritional condition [12]; studying, understanding the life cycle of fish species and it contributes to adequate management of these species, hence, maintaining the equilibrium in the ecosystem [13,14].

Condition factor is affected heavily by both biotic and abiotic environmental conditions and can be used as an index to assess the status of the aquatic ecosystem in which fish live [3]. Age of fish, sex, season, stage of maturation, fullness of gut, type of food consumed, amount of fat reserve and degree of muscular development all are biotic and abiotic factors that influence the value of "K" [15].

Condition factors of different tropical fish species were investigated and reported by [12, 16] and [6]. The identification of fish fauna of any aquatic habitat is regarded paramount before its exploitation of available resources. The study was investigated to determine the species diversity, abundance, and condition factor of fish species from Challawa Gorge Dam.

2. Materials and Methods

2.1 Study Area

Challawa gorge dam is located at $8^0 06' 58.04''$E latitude $11^0 41' 21.95''$N longitude (Google Earth, 2016) in Karaye Local Government of Kano State in the Northwest of Nigeria, about 90 km southwest of Kano city. It is a major reservoir on the Challawa River, a tributary of the Kano River, while Kano River is the main tributary of the Hadejia River [17]. The dam was built by Julius Berger Nigeria in 1990-1992 using rock fill construction. It is 42 m high and 7.8 km in length. The dam has a full storage capacity of 904,000,000 m^3. The direct catchment area is 3857 km^2 [18]. Apart from irrigation; fishing, and township water supply, the dam was constructed with hydropower potential of around 3MW [19]. Due to lack of stability of the soil at the periphery of the dam, the dam is gradually being silted [20]

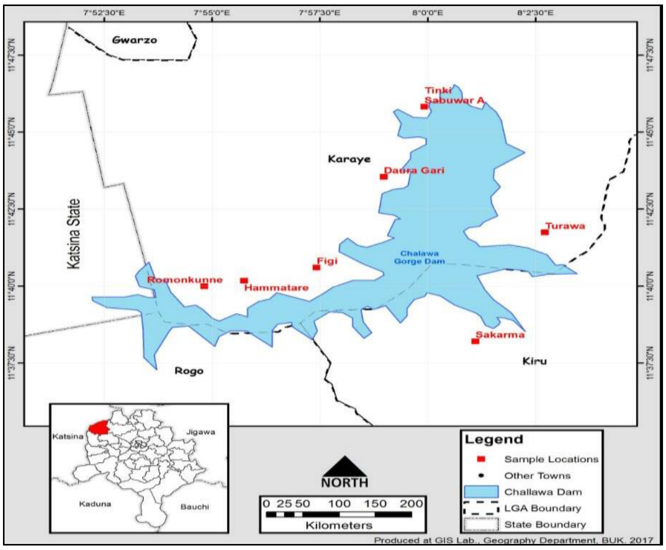

Fig 1: Map of Challawa Gorge Dam Showing Study Sites

2.2 Fish sampling protocols

Three landing sites (Feginma, Turawa, and Sakarma) were used for fish sampling. Samples were obtained from the local fishermen at each of the landing sites. Fishing gears that were used by the local fishermen includes gill and cast nets of different mesh sizes (2, 2.5, and 3 inches). Fish species identification was done with the aid of reference materials [21] and [22]. Fish sampling were carried out over a period of six (6) months (March to August).

Indices of diversity were used to describe the diversity of the fish communities in the dam as follows:

Margalef's Index (D) for species richness (Margalef, 1968).

$$D = (S-1)/\ln N \quad \ldots\ldots (1)$$

Where S = number of species and N = number of individuals.

The Shannon-Wiener's Index (H') of species diversity (Shannon & Wiener, 1963);

$$H' = -\sum P_i \ln P_i \quad \ldots\ldots (2)$$

Where P_i, is the proportion of the total number of individuals occurring in species i.

Pielou's Index (J) for species evenness (Pielou, 1969);

$$J = H'/\ln S \quad \ldots\ldots (3)$$

Where H' is the species diversity index and S is the number of species.

Fulton's condition factor was calculated for each of the

species, using the expression $k = 100W/$

(L^3)……...…… (4)

Where W= weight (g), L= length in (cm).

Condition factor (K) of fish species from the three selected sites were analyzed using ANOVA on Minitab Statistical tool (V 18). Two-way analysis of variance at 0.05 probability levels was used.

Comparisons for Mean K

Tukey Pairwise Comparisons: Species identified

Grouping Information Using the Tukey Method and 95% Confidence

Species identified	N	Mean	Grouping			
Marcusenius senegalensis	6	2.00000	A			
Oreochromis niloticus	6	1.95100	A			
Brycinus nurse	6	1.31033		B		
Marcusenius isidori	6	1.22333		B	C	
Lates niloticus	6	1.03267		B	C	D
Clarias lazera	6	0.88867			C	D
Auchenoglanis occidentalis	6	0.87900			C	D
Synodontis gambiensis	6	0.87200			C	D
Bagrus bayad macropterus	6	0.87187			C	D
Schilbe mystus	6	0.71200				D

Means that do not share a letter are significantly different.

3. Results

3.1 Fish Species Identified

A total of ten (10) species were recorded over a period of six months March to August, 2017 (Table 1). These species belong to nine families, family Mormyridae had the highest number of species represented by *Marcusenius isidori* and *Marcusenius senegalensis*. Besides family Mormyridae, the other families were represented by one species each. Family Bagridae was represented by *Bagrus bayad macropterus*. Family Latidae represented by *Lates niloticus*, family Alestidae was represented by *Brycinus nurse*, *Oreochromis niloticus* represented family Cichlidae, family Claridae was represented by *Clarias lazera*,. *Auchenoglanis occidentalis* represented the family Claroteidae, whereas *Synodontis schall* represented family Mochokidae. And *Schilbe mystus* represented the family Schilbeidae (Table 1).

Table 2: Fish species identified in Challawa Dam

Family	Species	English name	Local name (Hausa)
Bagridae	*Bagrus bayad macropterus*	Silver catfish	Ragon ruwa
Latidae	*Lates niloticus*	Nile perch	Giwan ruwa
Alestidae	*Brycinus nurse*	Silversides fish	Kawara
Cichlidae	*Oreochromis niloticus*	Nile tilapia	Karfasa
Claridae	*Clarias lazera*	Catfish	Tarwada
Claroteidae	*Auchenoglanis occidentalis*	Bubu, armored Catfish	Buro
Mochokidae	*Synodontis schall*	Wahrindi	Karaya
Mormyridae	*1. Marcusenius isidori 2. Marcusenius senegalensis*	Trunkfish	Farinwata Data
Schilbeidae	*Schilbe mystus*	Butterfish	Balo

3.2 Fish Species Composition

The fish species composition is presented on Table 2. *Auchenoglanis occidentalis*, *Lates niloticus*, *Marcusenius senegalensis* account for 2.87%, 2.47%, and 32.60% of the total fish caught. This is followed by *Marcusenius isidori* 21.05%, *Oreochromis niloticus* had 12.46% of the total fish caught. The remaining families' representative had less than 9% of the total fish stock each which includes *Brycinus nurse* 8.35%, *Schilbe mystus* 5.88%, *Bagrus bayad macropterus* 5.67% and *Clarias lazera* 5.15% respectfully (Table 2).

Table 2: Fish Species Composition.

Species/Month	March	April	May	June	July	August	Total	% Abundance
Auchenoglanis occidentalis	0	0	31	56	20	16	123	2.87
Bagrus bayad Macropterus	3	31	49	46	55	59	243	5.67
Brycinus nurse	1	63	187	35	42	30	358	8.35
Clarias lazera	14	41	63	49	35	19	221	5.15
Lates niloticus	1	30	15	29	27	04	106	2.47
Marcusenius isidori	6	177	204	319	186	10	902	21.05
Marcusenius senegalensis	6	297	402	390	294	08	1397	32.60
Oreochromis niloticus	9	104	228	109	58	26	534	12.46
Schilbe mystus	2	28	69	49	67	37	252	5.88
Synodontis schall	2	30	54	38	11	14	149	3.47
Grand total	4285							

Diversity indices

Margalef's diversity index	1.07
Shannon Wiener's species richness	2.28
Pielou's index for species evenness	0.99

3.3 Fish species condition factor

The fish condition factor of each of the species identified is presented on Table 3. The table reveals that *Marcusenius senegalensis* has the highest K-value with 2.0. This is followed by *Oreochromis niloticus* with a K- value of 1.95. *Brycinus nurse* is next with a K-value of 1.31. A significant number of species have K-value within the range of 1.03 to 1.22 which of course includes *Marcusenius isidori* and *Lates niloticus*. The remaining species represent the lowest K-value within the range of 0.71 to 0.88 (Table 3).

Analysis of variance at 0.05 probability level ($P<0.05$) revealed a significant difference in the K-value between the species, but there's no significant difference between the sites in terms of K-value.

Table 3: Fish Species Weight and Condition Factor.

Fish Species	Total weight (g)	% Total weight (g)	Condition factor (K)
Auchenoglanis occidentalis	4351.1[b]	7.62	0.87[b]
Bagrus bayad	22748.2[a]	39.84	0.87[b]
Brycinus nurse	520.2[c]	0.91	1.31[b]
Clarias lazera	5907.5[b]	10.34	0.88[b]
Lates niloticus	10657.4[b]	18.66	1.03[b]
Marcusenius isidori	419.5[c]	0.73	1.22[b]
Marcusenius senegalensis	241.3[c]	0.42	2.00[a]
Oreochromis niloticus	6621.5[b]	11.59	1.95[a]
Schilbe mystus	2324.8[c]	4.07	0.71[b]
Synodontis schall	3304.4[b]	5.78	0.87[b]

Column with different superscript letter are significantly different.

4. Discussion

4.1 Fish species biodiversity

In this study, a total of ten (10) species belonging to nine (9) families were identified and recorded with mormyrids being the dominant species in the fish community. This fish species composition of Challawa gorge dam is in line with the works of [14] where twelve 12 species belonging to six (6) families were recorded at Dogon ruwa water body with cichlids being dominant species, and [5] reported eleven (11) species belonging to five (5) families from Usuma Reservoir. However, the fish species composition of Challawa dam is higher than that of [9], who reported a total of eight (8) species belonging to four (4) families in Katsina State water body. This may be due to the large size of Challawa dam which may accommodate large volume of species. However, the Challawa dam fish species composition is lesser than the findings of [1] who reported twenty six (26) species belonging to 14 families with bagrids and mormyrids being the dominant species in Dadin-kowa dam, fifteen (15) species belonging to eleven (11) families were reported in the same Dadin-kowa dam [3]. The low species representation of the Challawa dam as compared to the aforementioned study sites may be due to the large size of dam, riverine tributaries, moderate fish exploitation and different lake-basin morphometry.

In this study; the dominance of mormyrids followed by cichlids is in line with the findings of [1] and [23]. The abundance in terms of species and number, this large number of individuals may be due to the availability of phytoplankton, diverse food supplements, prolific capabilities and good parental care as stated by [7]. Also [15] stated that fish adaptability to lacustrine environment attributes to their dominance.

However, *Lates niloticus* with one hundred and six individuals (106) had the least abundance. This may be due to their food preference, being carnivorous; their low abundance will serve as a checkmate for the most prolific species such *Marcusenius senegalensis* and of course it's desirable nature by humans.

The number of fish species present in natural aquatic ecosystem (species richness) increases with lake size, presumably because lake size is correlated to habitat diversity [24]. Species richness in natural lakes is also affected by physical (latitude and altitude) and chemical parameters (such as TDS, pH, conductivity) attributes of individual lakes [25].

4.2 Fish Species Condition Factor (K)

In this study, the condition factor showed that out of the ten (10) species identified; 50% of these species had K values within the range of 0.01 to 0.87 with *Schilbe mystus* having the least K value of 0.71, this K value coincides with K values of *Polypterus ansorgei* as recorded by [26]. The other 50% had K values within the range of 1.0 to 2.0 with *Marcusenius senegalensis* having the highest K value of 2.0, this result is in line with the K values of *Tilapia zilli* [27]. K values, is not constant for individuals, species, population, but is subject to wide variations for fish of an average natural conditions [3], the results of this study showed below and average of fish. Generally however the differences in K values between and within species are attributable to the differences in stress level, sex, season, availability of feeds, and water quality parameters [27]. In this study, the 50% of species with low or below K values may had been subjected to uncontrolled exploitation through the use of non-selective gears (Yan taru). The maintenance of good Physico-chemical parameters and their influx into water system, sufficient regulation of fishing and its practices, non-selective gears restriction and enforcement by relevant authorities, public enlightenment on the dangers of biodiversity loss can greatly enhance and maintain the dynamics of the dam.

5. Conclusion

Assessment of fish biodiversity revealed 10 species belonging to 9 families with the mormyrids (*Marcusenius isidori* and *Marcusenius senegalensis*) being the dominant species. *Lates niloticus* has the least distribution, hence it is carnivorous. The least number of *Lates niloticus* can serve as a checkmate on the proliferous mormyrids species. Condition factor (K value) of fish species identified revealed that 50% of the species investigated had their K value below 1, whereas the

remaining 50% had above, these values represent below and average wellbeing of fish.

The maintenance of good Physico-chemical parameters and their influx into water system, sufficient regulation of fishing and its practices, non-selective gears restriction and enforcement by relevant authorities, public enlightenment on the dangers of biodiversity loss can greatly enhance and maintain the dynamics of the dam.

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