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Original Article

Distribution and abundance of cichlids in the New Calabar River, Nigeria

Olaniyi Alaba Olopade • Henry Eyina Dienye

Department of Fisheries, University of Port Harcourt, Nigeria.

Correspondence
Dr. Olaniyi Alaba Olopade; Department of Fisheries, University of Port Harcourt, Nigeria.
Olaniyi.olopade@uniport.edu.ng

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Abstract

This study was conducted to study the distribution, abundance and diversity of the cichlids in the New Calabar River, Nigeria. A total of 1073 cichlids belonging to ten species and seven genera (*Coptodon guineensis*, *C. zillii*, *C. dageti*, *Pelmatolapia mariae*, *Hemichromis fasciatus*, *Pelvicachromis taeniatus*, *Chomidotilapia guntheri*, *Tylochromis sudanensis*, *Sarotherodon galilaeus* and *S. melanotheron*) were collected from three sampling stations between February and July, 2017. The most abundant species, in terms of number, was *C. guineensis* comprising 33.3% of all the number of species recorded followed by *C. zillii* (19%) and *S. galilaeus* (16.7%) while in terms of weight the dominant cichlids were *C. guineensi* (38.4%), *C. zillii* (19.6%) and *S. melanotheron* (12.9%). Five species, *C. guineensis*, *S. melanotheron*, *S. galilaeus*, *C. dageti* and *C. zillii* were recorded throughout the months of study. The Shannon-Weaver diversity index was found the highest (1.5) at Station 1 and the lowest (0.93) at Station 3 while Pielou's evenness index was the highest (0.77) at Station 1.

Keywords: Cichlidae; New Calabar River; finfish diversity; Nigeria

1 | INTRODUCTION

The population size of species in a habitat eventually tends towards a dynamic equilibrium at a given time, dictated by the available resources (Ndu *et al.* 1991). Such dynamic equilibrium is known as balance in nature even though the community does not remain the same all the time, but undergoes charges (Molles 1948). According to Pandey and Skukla (2005) the size of the total stock of the group of fish species vary to a great extent from year to year and from region to the other. These fluctuations in abundance are caused by natural factors, apart from those caused by human activities. White and Pickett (1985) listed 26 major sources of disturbance roughly divided into abiotic forces, biotic and human- caused disturbance. Regardless of the source, intermediate levels of disturbance promote higher diversity (Molles 1948).

Fish distribution and abundance in different habitats is associated with availability and abundance of food and substrate types in a particular habitat (Welcomme 1985). Use of habitats by some fish species is strongly influenced by spatial and temporal changes in the physicochemical factors, which are related to feeding, resting and reproduction (Braeten and Guy 1999). Stability also, depends on the structure of ecosystems, such as types of interaction (e.g., predation, mutualism, or competition; Allesina and Tang 2012; Mougi and Kondoh 2012).

In terms of human activities, the major threats to river systems throughout the world are pollution, overharvesting of biotic resources, destruction of supporting riparian and flood plain ecosystems, alteration and regulation of flow (e.g. Molles 1948; Mohsin *et al.* 2013; Chaki *et al.* 2014; Joadder *et al.* 2015; Galib *et al.* 2016, 2018).

Generally, cichlids occur in a great range of habitats from warm water open to the sun to shaded forest waters, clear nutrient poor rivers to brackish estuaries (Lowe-McConnell 1991). Cichlid species flocks are primarily monophyletic groups of closely related species inhabiting the same ecosystem, and evolved from a single ancestral species (Greenwood 1974). Their abundance have been associated to natural-history traits such as high reproductive rates, high rates of juvenile and adults survival or strong competitive abilities that allow them to dominate other species (Van Dyke 2002). Many members of this family are commercially important in aquaculture and the ornamental fish trade (Pullin 1991).

The cichlids are esteemed as food; affordable and supporting both small scale subsistence and commercial fisheries worldwide (e.g. Mohsin *et al.* 2009; Imteazzaman and Galib 2013) including Nigeria. Cichlidae family is one of the major commercial fish species commonly caught in the New Calabar River and one of the most desirable fish species. Fish catches have over time dwindled and currently the catch per unit effort is relatively low to be of significant economic importance to the fishing communities. In spite of the economic importance of cichlids in the Nigeria, there is little research on their composition, distribution, diversity and management. The present research work therefore, aims at investigating composition, distribution and diversity of the cichlids in the New Calabar River which will be helpful in the management and development of fishery in the river.

2 | METHODOLOGY

2.1 | Study area and duration

The study was carried out in the New Calabar River of Rivers State, Nigeria which is a partially mixed estuarine river (Figure 1). The climate is tropical, with high rainfall and annual precipitation of 2372 mm (range 2000 – 3000 mm; Abowei 2000). The climate consists of wet season (April – September/October) and dry season (October/November – March). The average annual mean relative humidity is 86% (66 – 96%) with mean annual temperature of 25°C ranging from 22 to 32°C.

2.2 Sampling

In order to determine the wider distribution of the cichlids in the New Calabar River fish samples were collected from three identified fishing sites *viz.* Aluu (upper reaches), Iwofe (middle reaches) and Choba/Aluu juncture (lower reaches) (Figure 1). Weekly field survey was carried out from February to July 2017 with the help of local fishermen using various fishing gears including beach net (10 – 15 m length, 2 – 3.5 m height, mesh size 0.5 – 5 cm), fixed gill net (40 – 60 m long, mesh size 15 – 57 mm), cast net (2 – 5 m diameter, mesh size 15 – 20 mm) and local traps (made from raffia palm; diameter 20 mm and 80 mm deep). Gillnets and traps were set between 1600 h and 1800 h and fishes caught were removed from the gear between 0600 h and 0859 h the next day. Dugout canoes with paddles were used during the sampling within the river. Fishes were identified after Adesaulu and Sydenham (2007). Fish specimens were measured to the nearest mm using a meter rule and weighed to the nearest 0.1 g with a top loading Satorius balance (model BP 310S). The sampling duration with the fishing gear and methods were approximately the same throughout the period and a uniform fishing effort at each station was used to standardise the sampling methods.

2.3 | Data analysis

A number of ecological indices were used to describe the diversity of cichlids in the New Calabar River are as follows:

Relative species abundance (%) = (n/N) × 100

Which refers to the relative representative of a species was determined by dividing the number of species (*n*) from each catch by the total number of species (*N*) from the total catch recorded.

Simpson's index, d = ∑n(n - 1) N (N - 1)

Where *n* is the number of individuals of a particular species, *d* is the diversity index and *N* is the total number of individuals present in the entire sample.

Simpson's index of diversity = (1 – d)

Simpson's reciprocal index = (1/d)

Shannon-Weiner's Index (*H'*) of species diversity, H'= – åPi ln Pi (Shannon and Weiner 1963)

Where *Pi* = the proportion of the total number of individuals occurring in species *i*, *n* is the number of individuals of each species, and *N* is the total number of individuals.

Pielou's Index (*J*) for species evenness *J* = H'/ln S (Pielou 1969)

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

3 | RESULTS

A total of 1073 cichlids were collected and recorded during the study period belonging to ten species and seven genera (Table 1). The most abundance species was *Coptodon guineensis* comprising 33.3% of all the number of species recorded followed by *Coptodon zillii* (19%) and *Sarotherodon galilaeus* (16.7%), while the least abundant species were *Chomidotilapia guntheri* (0.6%), *Hemichromis fasciatus* (0.6%) and *Tylochromis sudanensis* (0.4%) (Table 1). In terms of weight the dominant cichlids

in the New Calabar River were *C. guineensi* (38.4%), *C. zillii* (19.6%) and *Sarotherodon galilaeus* (12.9%) and the least were *T. sudanensis* (0.4%), *C. guntheri* (0.3%) and *H. fasciatus* (0.3%).

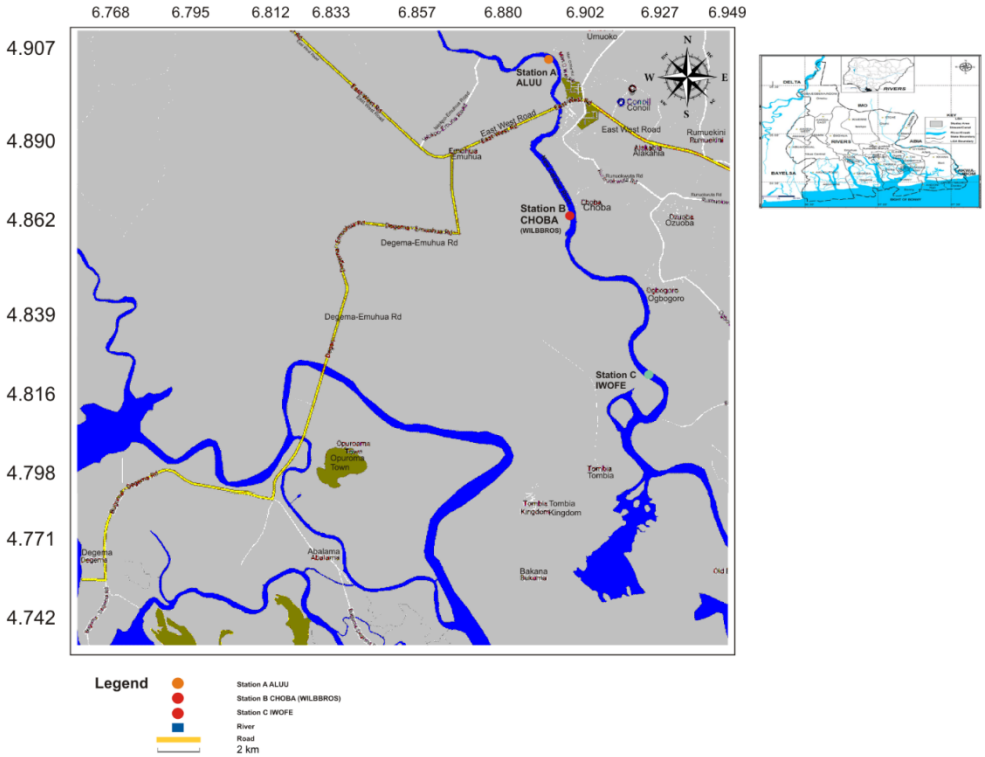

FIGURE 1 Showing the sampling sites and Nigeria map

TABLE 1 Percentage representation of cichlids by number and weight in the New Calabar River

Species	*N*	*%N*	*Wt (kg)*	*%Wt*
Coptodon guineensis	357	33.3	36.89	38.36
Coptodon zillii	204	19.0	19.62	20.40
Coptodon dageti	117	10.9	11.23	11.68
Sarotherodon melanotheron	153	14.3	12.44	12.93
Sarotherodon galilaeus	179	16.7	11.35	11.80
Pelmatolapia mariae	25	2.3	1.81	1.88
Chomidotilapia guntheri	6	0.6	0.33	0.34
Pelvicachromis taeniatus	22	2.1	1.85	1.92
Hemichromis fasciatus	6	0.6	0.31	0.32
Tylochromis sudanensis	4	0.4	0.35	0.36
Total	**1073**		**96.18**	**100**

The monthly distribution of cichlids caught during the study is presented in Figure 2. The results showed that *C. guineensis*, *S. melanotheron*, *S. galilaeus*, *C. dageti* and *C. zillii* were recorded throughout the months of study. Whereas *T. sudanensis* was found only in February accounting for 3.9% of the total catch in the month. Other fishes like *P. mariae*, *H. fasciatus* and *P. taeniatus* were not available throughout the sampling period.

The number of fish species in station 1 was the lowest compared to fish species found in two other stations. Three species, *H. fasciatus*, *P. taeniatus* and *T. sudanensis* were not recorded in station 1 whereas, *P. taeniatus* and *C. guntheri* were not found in station 2 and station 3 respectively (Table 2). The diversity indices indicated low diversity in stations. Seven species of cichlid was recorded in station 1, while nine species were found in station 2 and 3. The Simpson's index of diversity for stations 1, 2 and 3 were 0.72, 0.69, and 0.77 respectively, while the Simpson's reciprocal index for stations 1, 2 and 3 were 3.58, 3.19, and 4.32 respectively. The Shannon-Weaver diversity index was found the highest (1.5) in station 1 and the lowest (0.93) in station 3. Pielou's evenness index was the highest (0.77) in stations 1 and followed by station 2 (0.49) and station 3 (0.42).

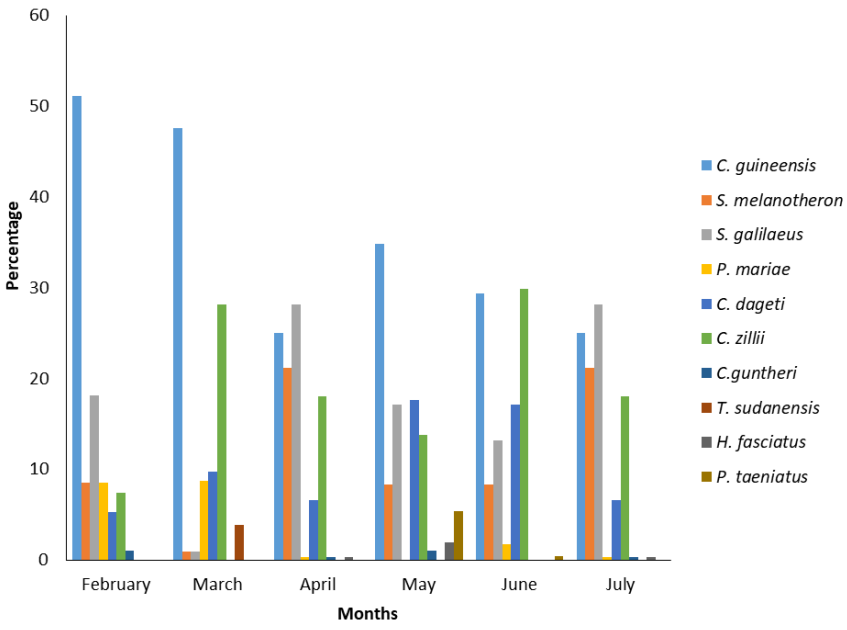

FIGURE 2 Monthly abundance and distribution of cichlids in the New Calabar River

TABLE 2 Availability of cichlids and diversity indices in the three sampling stations in the New Calabar River

Cichlid species	***Stations***		
	1	***2***	***3***
Coptodon guineensis	+	+	+
Sarotherodon melanotheron	+	+	+
Sarotherodon galilaeus	+	+	+
Pelmatolapia mariae	+	+	+
Coptodon dageti	+	+	+
Coptodon zillii	+	+	+
Chomidotilapia guntheri	+	+	-
Tylochromis sudanensis	-	+	+
Hemichromis fasciatus	-	+	+
Pelvicachromis taeniatus	-	-	+
Diversity Index			
Number of species	7	9	9
Number of individuals	129	441	503
Simpson's index	0.28	0.31	0.23
Simpson's index of diversity	0.72	0.69	0.77
Simpson's reciprocal index	3.58	3.19	4.32
Shannon-Weiner index	1.5	0.97	0.93
Pielou's evenness index (J')	0.77	0.44	0.42

-, absent; +, present

4 | DISCUSSION

The result indicated that 10 species of cichlid was found in the New Calabar River. The family Cichlidae has eleven genera and 19 species in freshwaters of Nigeria and the ten species presence in this study have been described as Nigerian freshwater fishes in Adesaulu and Sydenham (2007). Holden and Reed (1978) reported over 200 species of cichlids in West African water bodies. Cichlids are poorly represented in most African riverine habitats because they thrive better in estuarine habitats including natural and man-made lakes (Lowe-McConnell 1987). Unavailability of some species in this study may indicate declining trend of the fish diversity. Ibim *et al.* (2016) reported nine species of cichlids from the same river. Onwuteaka (2015) reported the presence of *S. galilaeus*, *C. guinensis*, *C. dageti*, *C. guntheri*, *P. taeniatus* in New Calabar River along with *C. zillii*, *H. fasciatus* and few other cichlid species in two others rivers *viz.* Orashi and Sombriero. This variation in results might be due variation in sampling procedure followed in this study. Majority of the recorded cichlids are also common in other Nigerian freshwater bodies. In the Osinmo Reservoir relative abundance of *T. zillii*, *S. galilaeus* and *H. fasciatus* were 36.3%, 17.58% and 7.69% respectively (Komolafe *et al.* 2014). In Gbedikere Lake, out of 12 species, *C. zillii* constituted about 13.01% of the total fish catch (Adeyemi *et al.* 2009).

The specimen collected in this study increased from month to month, with the highest catch achieved during the wet season (February – April). The marked differences in seasonal abundance could also possibly be due to habi-

tat preferences associated with water levels in the river (Gordon 2003).

In this study more cichlids were recorded in sampling station 2 and 3. In a similar study in the River Kisian and Awach of Kenya Mwangi *et al.* (2012) reported that community structure (species diversity, richness and evenness) were generally higher in the middle and lower reaches. The station 2 and 3 are influenced by proximity of the Atlantic Ocean which make the two stations slightly complex. Genner *et al.* (2004) reported that shoreline slopes, water transparency and predation can affect cichlid dispersal and food supply.

Diversity indices provide more information than simply the number of species present and they serve as valuable tools that provide important information on rarity and commonness of species in a community (Galib *et al.* 2013). Shannon-Weiner's index value from 3.0 – 4.5 represents better condition of water body for fish. But in the present study this value varied from 0.93 to 1.5 which is lower than the recommended range which could be attributed to the impacts of human activities especially sand mining/dredging, unregulated fishing, domestic and industrial pollution in the studied river. Simpson's index values range from 0 to 1, with 1 representing perfect evenness (all species present in equal number). In this study Simpson's indices varied between 0.69 and 0.77 which is less than 1 indicating imperfect evenness (Olopade and Rufai 2014). The values recorded in the present study ranged from 3.19 to 4.32 indicate that cichlid species were highly distributed. The higher the value, the greater the diversity, therefore station 3 had the most diverse cichlid species (Lawson and Olusanya 2010).

5 | CONCLUSION

The study revealed that only ten cichlids were recorded in the New Calabar River and most abundance was *C. guineensis* while *C. guineensis*, *S. melanotheron*, *S. galilaeus*, *C. dageti* and *C. zillii* were recorded throughout the period of study. The poor health of the river was reflected by the diversity indices considered in this study. Further research and survey work are highly recommended to reveal more information on spatial distribution existing threats to aquatic biodiversity.

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CONTRIBUTION OF THE AUTHORS

OAO research design and supervision, manuscript preparation; **HED** research design and data collection

Olaniyi A Olopade https://orcid.org/0000-0002-9550-2956
Henry E Dienye https://orcid.org/0000-0001-6254-9179