FISH COMMUNITY STRUCTURE IN A NATURAL RAINFOREST LAKE, NIGERIA

[1]IBEMENUGA, Keziah Nwamaka, [1]OPARA, Prudentia Ogochukwu and [2]OKEKE, John Joseph

[1]Department of Biological Sciences, Chukwuemeka Odumegwu Ojukwu University, Uli, Anambra State, Nigeria.

[2]Department of Zoology, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.

Corresponding Author: Ibemenuga, K. N. Department of Biological Sciences, Chukwuemeka Odumegwu Ojukwu University, Uli, Anambra State, Nigeria. **Email:** ibemenugakn@gmail.com **Phone:** +234 8126421299

ABSTRACT

Studies on fish community of Agulu Lake were conducted from April to July 2015. Fish samples were bought from fishermen who caught them using gillnets and traps. A total of 159 fish samples belonging to 3 orders, 7 families, 8 genera and 10 species were obtained during the study. Station I had the highest fish abundance of 50.9 %, while station III had the lowest fish abundance of 23.5 %. Fishes belonging to the order Perciformes were the most abundant (66.04 %) of the total catch. This was followed by Siluriformes (31.43 %). The least order Osteoglossiformes was represented by 1.26 % of the total fish caught. Cichlidae, the most abundant family, has the highest number (103, 64.78%) of fish caught from the lake. The monospecific families encountered in the study were Channidae (Parachanna obscura), Bagridae (Chrysichthys nigrodigitatus), Mochokidae (Synodontis ocellifer), Malapteruridae (Malapterurus electricus) and Notopteridae (Papyrocranus afer). The highest number of fish was caught in May (52, 32.7 %) and the lowest number of fish was caught in July (28, 17.6 %). The general diversity index (H) was highest (0.741) in station I and lowest (0.605) in station II. Evenness (E) followed the same trend being highest (0.741) in station I and lowest (0.670) in station II. Dominance was maximum (0.342) in station II and minimum (0.270) in station 1. The same trend was observed in Simpson's index which was highest (0.324) in station III and lowest (0.258) in station I.

Keywords: Fish community, Clariidae, Cichlidae, Channidae, Malapteruridae, Notopteridae, Rainforest, Agulu Lake

INTRODUCTION

Fish is a two chambered heart vertebrate that spends its entire life in water in order to live and undergo its necessary life activities. Fish is a very highly preferred, traded and edible aquatic resource all over the world (Ekpo *et al*., 2014). A species of fish occupying a particular area at a particular time constitutes fish population. Different populations of fish inhabiting particular water body at a particular time forms a fish community. Members of a fish community are diverse in species and feeding habits (omnivorous, herbivorous, plantivorous and piscivorous) and occupy different trophic levels. Biological communities vary in time and space as a result of differences in habitat structure (Gorman and Karr, 1978), resource availability (Grenouillet *et al*., 2002) and biogeographical patterns (Jackson and Harvey, 1989; Tonn *et al*., 1990; Matthews and Robinson, 1998). Thus, there is need for detailed knowledge of fish species in our natural waters and their response to various abiotic and biotic components of waters that is needful for adequate management and sustainability. Studies on fish communities include Victor and Tetteh (1988) in Ikpoba River, Ikomi *et al*. (1997) in River Jamieson, Ogbeibu and Ezeunara (2002) in Ikpoba River, Ogidiaka *et al*. (2013) in Warri River and Anigboro *et al*. (2014) in Iyi-Ekpen Stream. However, apart from the study of Chukwujekwu and Chidi (2013) on the fish fauna of Agulu Lake, no other report exists on the fish community structure of Agulu Lake. The present study was carried out to provide information on the fish community structure, species abundance and distribution, needful for the sustainable management of the lake and its fishery resources.

MATERIALS AND METHODS

Description of the Study Area: The study was carried out in Agulu Lake in Anaocha Local Government Area of Anambra State, Nigeria (Figure 1).

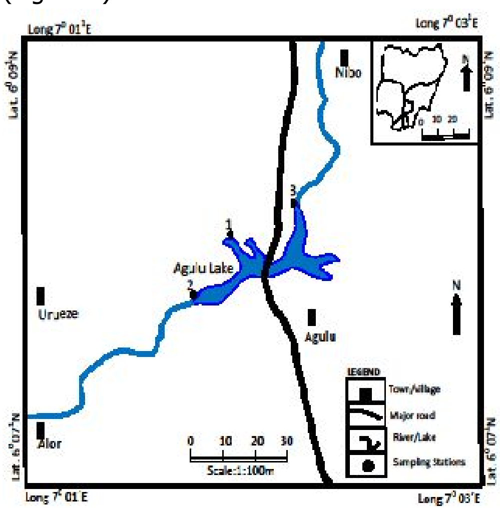

Figure 1: Map of Agulu Lake showing the sampled stations

Agulu Lake lies within latitude 6° 07' and 6° 09' N and longitude 7° 01' and 7° 03' E in Anambra Basin (Okoye *et al*., 2014). It is a natural lake and the area is underlain by the Eocene (tertiary) shallow marine to continental Ameki Formation, which is dominantly sandy with purple, white, grey, pink, clay-shale-silt bands (Offodile, 2002; Eyo *et al*., 2008). The six-armed lake serves the local population by provision of water for farming, washing, fishing and domestic use.

Other activities associated with the lake include construction of Lake Resort for tourism, dumping of wastes and ritual sacrifices. Agulu Lake is the largest lake in Anambra State. It has three permanent surface water sources namely Idemili Omelagha, Utokoloafo and Egbulumawolo streams (Inyang and Ezenwaji, 2004). The climate is tropical and consists of wet season (April – September/October) and dry season (October/November – March).

Stations: Three sampling stations were studied. Station I was characterized by mud and sand. Human activities in this station include fish rearing in fish ponds, deposition of chippings within the catchment area and packing of company trucks in a garage constructed with barbwire. Macrophytes in this station included *Costus afar, Saggiteria* sp. and *Elaeis guineensis*.

Station II was characterized with sand, mud and debris in some places. Washing of clothes, breadfruit, fishing and swimming were among human activities occurring in this station. Plants growing along the banks included *Elaeis guineensis, Raphia hookeri* and *Persea americana*.

Station III had sand and debris. Washing of cars, motor cycles, construction of a Lake Resort and deposition of waste were among human activities occurring in this station. Macrophytes in this station included *Elaeis guineensis, Eichhornia crassipes, Ceratophyllum* sp. and *Saggiteria* sp.

Fishes: Fishes were collected fortnightly from fishermen who caught the fishes with different fishing gears including gillnet and traps (Eyo and Akpati, 1995). The sampling was carried out for four months (April – July 2015). The fishes caught were immediately preserved in 10 % formalin and transported to the laboratory for observation and identification. Fish sampled were identified to species level using the taxonomic keys of Olaosebikan and Raji (1998) and Idodo-Umeh (2003).

Data Analysis: Fish species compositions were analyzed using simple percentage. Bellinger's coefficient, Margalef index of species richness (d), Shannon-Wiener diversity index (H) and species evenness or equitability (E), dominance (C) and Simpsons index (D) were analyzed using the methods of Zar (1984). Analysis of variance (ANOVA) was used to test for significant difference among the sampling stations.

RESULTS

Fish Species: Table 1 showed the fish species composition, abundance and distribution at the sampled stations of Agulu Lake. A total of 129 fish sampled during the study, belonged to 3 orders, 7 families, 8 genera and 10 species. Station I had the highest fish abundance (81, 50.9 %), while station III had the least abundance (37, 23.3 %) (Figure 2). Analysis of variance showed that the fish abundance at the studied stations differed significantly ($p<0.05$). All the fish species (100 %) encountered during the study occurred in station I. Eighty percent (80 %) and 60 % of the species were recorded in stations II and III respectively. *Tilapia zilli* which recorded 50.69 % of the total catch was the most abundant taxon in the Lake. It dominated the fishes sampled from the three stations. This was followed by *Clarias gariepinus* (21, 13.21%), *Tilapia mariae, Sarotherodon galilaeus* and *Clarias anguillaris* among others. *Clarias gariepinus* occurred at all the sampled stations. However, some species were restricted in distribution. *Parachanna obscura* and *Papyrocranus afer* occurred in stations I and II, while *Synodontis ocellifer* occurred in stations II and III. *Malapterurus electricus* was collected only in station I.

Fish Orders: Table 2 showed the abundance and distribution of fish orders at the sampled stations. Perciformes was the most abundant order and dominated fish sampled from the various stations. It was ubiquitous in distribution, contributing 60.49 % at station I, 75.61 % and 67.57 % in stations II and III respectively (Figure 3). It had the highest number of fishes (105) which represented 66.04 % of the total catch. Siluriformes, the next abundant order occurred in all the studied stations contributing 38.27 % in station I, 21.95 % in station II and 32.43 % in station III. It accounted for 32.70 % of the total catch. The least order Osteoglossiformes was occasional encountered in stations I and II (2.44 %) and was absent in station III. It contributed 1.26 % of the total fish captured in the study.

Fish Families: The composition and abundance of fish species and families caught from Agulu Lake is presented in Table 3. Cichlidae was the most abundant family with the highest number (103) of fishes. It formed 64.78 % of the total fish caught from the lake. The next abundant family was Clariidae with 27 individuals which contributed 16.98 % of the total catch. The families Channidae, Malapteruridae and Notopteridae each had the lowest number (21) with the least contribution of 1.26 % each of the overall catch. The family Cichlidae had the highest number of species (3) followed by Clariidae (2) with respective percentage contribution of 30 % and 20 %. Channidae, Bagridae, Mochokidae, Malaptruridae and Notopteridae with 1 species each, accounted for 10 % each to the total fish species caught during the study.

Monthly Variations: The abundance and distribution of fish species and families in relation to months is shown in Table 4. There was variation in total number of fish caught in relation to months. The highest number of fish was caught in May (52, 32.7%) and the least number of fish was caught in July (28, 17.6 %) (Figure 4). Fish families varied in relation to months. Generally only the families Cichlidae, Clariidae and Mochokidae which constituted 43 % of the families recorded in the study showed ubiquitous distribution while the rest of the families (57 %) were restricted in distribution. The family Cichlidae, the most diverse in species composition, dominated the samples in all the months (Figure 5). It was very prominent in April where it contributed 71.05 % of the total catch.

Table 1: Percentage composition and abundance of fish caught from Agulu Lake, Nigeria (April – July 2015)

Taxa	Stations			Total
	I	II	III	
PERCIFORMES **Cichlidae**				
Tilapia zilli	38(46.91)	23(56.10)	20(54.05)	81(90.90)
Tilapia mariae	8(9.88)	5(12.20)	4(10.81)	17(10.69)
Sarotherodon galilaeus	2(2.47)	2(4.88)	1(2.70)	5(3.14)
Channidae				
Parachanna obscura	1(1.23)	1(2.44)	0(0.00)	2(1.26)
SILURIFORMES **Clariidae**				
Clarias anguillaris	4(4.94)	1(2.44)	1(2.70)	6(3.77)
Clarias gariepinus	8(9.88)	7(17.07)	6(16.22)	21(13.21)
Bagridae				
Chrysichthys nigrodigitatus	5(6.17)	1(2.44)	2(5.41)	8(5.03)
Mochokidae				
Synodontis ocellifer	12(14.81)	0(0.00)	0(0.00)	2(1.26)
Malapteruridae				
Malapterurus electricus	2(2.47)	0(0.00)	0(0.00)	2(1.26)
OSTEOGLOSSIFORMES				
Notopteridae				
Papyrocranus afer	1(1.23)	1(2.44)	0(0.00)	2(1.26)
Total	81	41	37	159(100.00)

Figures in parenthesis are percentage abundance

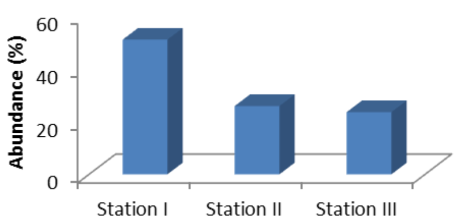

Figure 2: Fish abundance in relation to sampled stations of Agulu Lake, Nigeria

It was of least importance in May (59.61 %). It was represented by three taxa namely *Tilapia zilli, Tilapia mariae,* and *Sarotherodon galilaeus*. The most abundant taxon was *Tilapia zilli* which dominated the samples in all the months. Only *Sarotherodon galilaeus* showed restricted distribution. Clariidae was fairly important in July (28.57 %). It had approximately equal percentage contribution in May (17.31 %) and June (17.07 %). Its contribution in April was less important. *Clarias anguillaris* and *Clarias gariepinus* were the representative taxa encountered in the study. *Clarias gariepinus* occurred in all the months and was very important in July where it accounted for 21.43 % of the total fish captured. *Clarias anguillaris* recorded in April, May and July was absent in June. The families Channidae, Bagridae, Mochokidae, Malapteruridae and Notopeteridae were mono-specific and were respectively represented by one taxon namely *Parachanna obscura, Chrysichthys nigrodigitatus, Synodontis ocellifer, Malapterurus electricus* and *Papyrocranus afer*. Mochokidae occurred in all the months and it was most important in May where it contributed 11.54 % of the total catch. Channidae, Bagridae, Matapteruridae and Notopteridae were restricted in distribution occurring in May and June, April and May, May and April and June respectively.

Species Diversity: Table 5 showed variation in species diversity among the sampled stations of Agulu Lake. Diversity indices of fish species evaluated showed that Margalef's taxa richness (d) and Shannon-Wiener index (H) were

Table 2: Distribution and composition to fish orders in relation to sampling stations of Agulu lake, Nigeria (April – July 2005)

Taxa	Stations			Total
	I	II	III	
Perciformes	49(60.49)	31(75.61)	25(67.57)	105(66.04)
Siluriformes	31(38.27)	9(21.95)	12(32.43)	52(32.70)
Osteoglossiformes	1(1.23)	1(2.44)	0(0.00)	1(1.26)
Total	81	41	37	159

Figures in parenthesis are percentage abundance

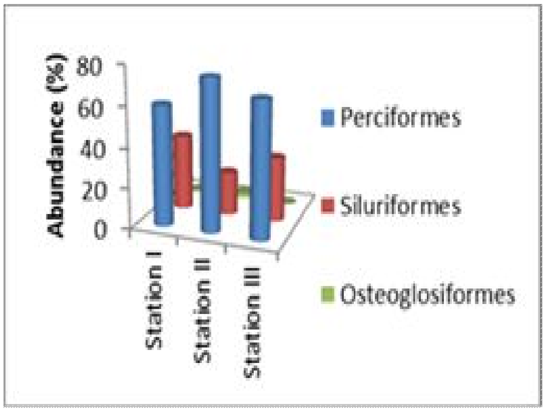

Figure 3: Abundance of major fish groups in relation to sampled stations of Agulu Lake, Nigeria

Table 3: Composition and abundance of fish species and families caught from Agulu Lake, Nigeria between April and July 2015

Taxa	Numbers of species	Total number of fish caught
Cichlidae	3(30.00)	103(64.78)
Channidae	1(10.00)	2(1.26)
Clariidae	2(20.00)	27(16.98)
Bagridae	1(10.00)	8(5.03)
Mochokidae	1(10.00)	15(9.43)
Malapteruridae	1(10.00)	2(1.26)
Notopteridae	1(10.00)	2(1.26)
Total	10(100)	159(100)

Figures in parenthesis are percentage abundance

maximum in station I and minimum in stations III and II respectively. Equitability or evenness (E) was highest in station I and lowest in station II. The highest (0.365) and lowest (0.270) dominance indices (C) were recorded in stations II and I respectively. Simpson's index (D) was highest (0.347) in station II and lowest (0.258) in station I.

Similarity Index: An evaluation of sampling stations using Bellinger's coefficient showed that station I was highly significantly different ($p<0.05$) from other stations. In terms of pairs of sampled stations, stations II and III were not significantly different ($p>0.05$). Other pairs of stations were significantly different ($p<0.05$) (Table 6).

DISCUSSION

The dominant orders namely Perciformes and Siluriformes were similar to the observation by Ekpo and Udoh (2013). The 10 species belonging to 7 families obtained in this study revealed that the ichthyofauna of Agulu Lake can be compared with 9 families with 19 species (Ikomi and Sikoki, 1998; Ikenweiwe *et al*., 2007) in Oyan Dam, and 6 families with 8 species (Ayanwale *et al*., 2013) in Tagwai Lake. The abundance of cichlids in this study is in consonance with Adeyemi *et al*. (2010) in Gbedikere Lake, Komolafe and Arawomo (2008) in Osinmo Reservoir and Mustapha (2009) in Oyun Reservoir. However, the ichthyofauna recorded in Agulu Lake is low when compared with 35 species from 20 families caught from Elechi Creek (Allison *et al*., 1997) and 45 species from 24 families captured from Urie Creek (Meye and Ikomi, 2008). The low piscifaunal abundance could be due to changes in water quality and habitat alteration caused by anthropogenic activities.

The family Cichlidae is particularly abundant in many African reservoirs. The dominance of Cichlidae has been reported in Kainji and Oyan lakes (Bankole *et al*., 1994; Olopade, 2010). Cichlid fishes are the most species rich family of all teleost fishes, and their diversity is centered in the great African lakes

Table 4: Variations of fish species and families in relation to months, Agulu lake, Nigeria (April – July 2015)

Taxa	April	May	June	July
Cichlidae	27(71.05)	31(59.61)	28(68.30)	17(60.72)
Tilapia zilli	19(50.00)	24(46.150	25(46.150	13(46.43)
Tilapia mariae	3(7.89)	7(13.46)	3(7.32)	4(14.29)
Sarotherodon galilaeus	5(13.46)	0(0.00)	0(0.00)	0(0.00)
Channidae	0(0.00)	1(1.92)	1(2.44)	0(0.00)
Parachanna obscura	0(0.00)	1(1.92)	1(2.44)	0(0.00)
Clariidae	3(7.89)	9(17.31)	7(17.07)	8(28.57)
Clarias anguillaris	1(2.63)	3(5.77)	0(0.00)	2(7.14)
Clarias gariepinus	2(5.260	6(11.54)	7(17.07)	6(21.43)
Bagridae	5(13.16)	3(5.77)	0(0.00)	0(0.00)
Chrysichthys nigrodigitatus	5(13.16)	3(5.77)	0(0.00)	0(0.00)
Mochokidae	2(5.26)	6(11.54)	4(9.76)	3(10.71)
Synodontis ocellifer	2(5.26)	6(11.54)	4(9.76)	3(10.710
Malapteruridae	0(0.00)	2(3.85)	0(0.00)	0(0.00)
Malapterurus electricus	0(0.00)	2(3.85)	0(0.00)	0(0.00)
Notopteridae	1(2.63)	0(0.00)	1(2.44)	0(0.00)
Papyrocranus afer	1(2.63)	0(0.00)	1(2.44)	0(0.00)
Total	38	52	41	28

Figures in parenthesis are percentage abundance

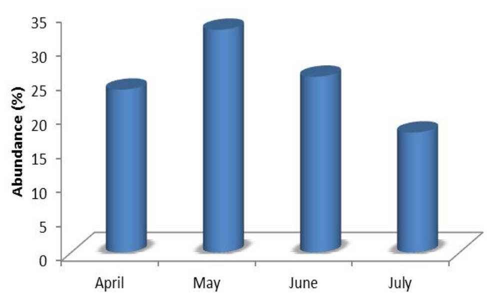

Figure 4: Fish abundance in relation to months from Agulu Lake, Nigeria

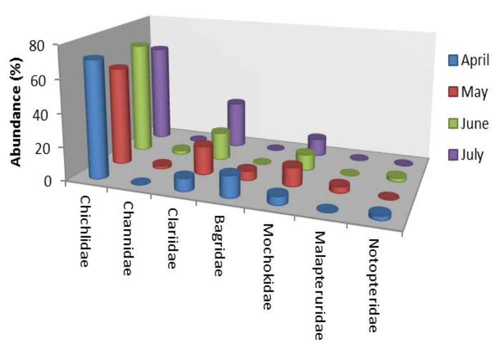

Fig. 5: Abundance of fish families in relation to months from Agulu Lake, Nigeria

Table 5: Diversity of fish in the study stations of Agulu Lake, Nigeria (April – July 2015)

Parameters	Stations		
	I	II	III
Number of taxa	10	8	7
Number of individuals	81	41	37
Margalef's richness index (d)	2.050	1.885	1.662
Shannon-Wiener (H)	0.741	0.605	0.619
Evenness index (E)	0.741	0.670	0.732
Dominance (C)	0.270	0.365	0.342
Simpson's index (D)	0.258	0.347	0.324

Table 6: Similarity coefficient of pairs of sampling stations of Agulu Lake, Nigeria (April – July 2015)

Stations	I	II	III
I	0.00		
II	5.00*	0.00	
III	6.00**	1.80	0.00

** Significantly different (p<0.05), ** Highly significantly different (p<0.01)*

where more than 2000 species has been recorded (Turner *et al*., 2001; Olopade and Rufai, 2014). The dominance of cichlids could be attributed to their prolific breeding habit (Adeyemi *et al*., 2010). Bankole *et al*. (1994) reported that the cichlids are found to breed three to four times in the year. Van Dyke (2003) attributed their abundance to natural trait such as high reproductive rates, high rate of juvenile and adult survival, or strong competitive abilities that allow them to dominate other species. Also cichlids have the ability to thrive on a wide range of food items (Daddy *et al*., 1991). Awfwuchs serve as additional food for cichlids (Ikomi *et al*., 1997; Anigboro *et al.,* 2014).

The largest number of fish encountered in May could be attributed to food availability and lesser rainfall resulting in low volume of water compared to higher volume of water in the more rainy months of June and July. This agrees with the findings of Ogbeibu (2001) who reported that higher faunal densities were recorded during the period of low water level. Generally, there is comparatively higher fish catches in the drier months than in the wet months probably due to lower volume of water, coupled with higher concentration of food and easier catchability and accessibility (Bolarinwa *et al*., 2015). The species diversity and dominance of Cichlidae over the months agreed with the findings of Ekpo *et al*. (2014) in Ikpa River. The monospecific families namely Channidae – *Parachanna obscura,* Bagridae – *Chrysichthys nigrodigitatus*, Mochokidae – *Synodontis ocellifer*, Malapteruridae – *Malapterurus electricus* and Notopteridae – *Papyrocranus afer* in this study is an indication that they were endangered. Industrialization, over exploitation, high anthropogenic activities and perennial occurrence of water hyacinth (Bolarinwa *et al.,* 2015) are among factors responsible for destruction and extinction of fish species.

Diversity indices calculated showed slightly highest values for station I than for stations II and III. The Shannon-Wiener index obtained in this study at the three stations was less than I, implying low species diversity of fish in Agulu Lake. Olopade and Rufai (2014) reported that the values of Shannon-Wiener diversity is usually found to fall between 1.5 and 3.5 and only rarely it surpass 4.5. Simpson's index which is an estimator for sampling from an infinite natural population (Ogbeibu, 2005) was less than 1 at the study stations. Olopade and Rufai (2014) reported that Simpson's index value range from 0 to 1, with 1 representing perfect evenness (all species present in equal number). The species were therefore unevenly distributed at the study stations.

Conclusion: The result of the present study revealed that Agulu Lake has great potential for fisheries. However, anthropogenic activities and other varied pollution sources to the lake should be monitored to ensure continued existence and boosting of fishery resources some of which are on the verge of destruction and extinction.

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