Vol. 3, No 1 June 2020
ISSN: 2016-1303 | ***Web:*** *www.cjpas.fulokoja.edu.ng*

SPECIES COMPOSITION AND ABUNDANCE OF ANURAN IN LOKOJA, KOGI STATE

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ABSTRACT
Anuran species composition and abundance was carried out at Lokoja Kogi state (Latitude of 07^{0}49´N and Longitude of 06^{0}45´E) for six months: February-April for the dry season and May- July 2018 for rainy season. Night transect virtual survey and active search survey methods were used. The anurans were grouped based on the habitat type. Identification was done by comparing captured animals with identification manual. A total of 901 individuals belonging to three families, three species were encountered. The species were Sclerophrys maculata, Hoplobatrachus occipitalis and Ptychadena mascareniensis. Sclerophrys maculata and Ptychadena mascareniensis with 603 and 71 individuals had the highest and lowest individuals. There were more individuals in the wet season than the dry season (190 and 711 respectively). The species were seen utilizing five different habitats; human settlement, water bodies, grassland, open habitat and riparian forest. The highest number of individuals were found in the riparian forest with 335 individuals. Species diversity did not differ between Water body (H 0.85), human settlement (H =0.78) and grassland (H 0.81). However, they differ with the open habitat with the lowest diversity index, H´0.36. The high relative abundance of Sclerophrys maculata may be due to its classification as an adaptable species occurring in wide variety of savanna, grassland and riparian forest. Ptychadena mascareniensis was the least abundant probably due to their ecological habitat requirement, cryptic habitat and reduced activity pattern. We therefor recommend that, water body, grassland, riparian forest and human settlement should be conserved equally as each habitat support a particular species.

Keywords*: Anuran, Composition, Abundance, Habitat type, conservation*

1.0 INTRODUCTION
The structure and diversity of amphibian community is determined by the availability of food and moisture (Daniel, 1992). Stream width and length have been seen to be major factors in the amount of frog species. Stream breeding frogs require a stream that is large enough to hold water for a sufficient length in time for their tadpoles to undergo metamorphosis (Parris & McCarthy, 1999). Many amphibian species moves away from temporal water bodies because their larval life span is longer than the duration of the water (Kats *et al.,* 1988). It has been observed that there was a correlation between habitat selection by animals and improved fitness, with ideal habitats supporting high population growth (Vonesh, 2001). Some studies have also tested the effect of habitat characteristics such as fragmentation, humidity, thickness of leaf litter, understory density, patch size, canopy cover and availability of water bodies and found that these factors were major determinants for the occurrence of anurans (Parris & McCarthy, 1999).

Anurans require unaltered habitats and specific microhabitat conditions due to their physiological requirements (Moore & Moore, 1980). This determines their distribution and habitat preferences leading to most species having restricted home ranges. Emergent diseases, habitat destruction, introduction of exotic species, and the pollution of both aquatic

Vol. 3, No 1 June 2020
ISSN: 2016-1303 | ***Web:*** *www.cjpas.fulokoja.edu.ng*

and terrestrial habitat have been described to contribute to the loss of anuran diversity and abundance (Stuart *et al.,* 2004). Fertilizers, pesticides heavy metals and road deicers are increasingly introduced into the environment by direct application, runoff from crops, forest application of mines, urban and industrial sewage and atmospheric deposition (Sparling, 2000). Documented effect of pollutant on amphibians ranges from lethal effect to sub-lethal including decreased growth and development, susceptibility to diseases and behavioral alteration (Shinn *et al*., 2007). Edaphic factors such as pH, humidity, type of soil and clay content are also factors affecting the distribution of many anurans (Vonesh, 2001). However, on a local scale, there are several other environmental factors that can also influence anuran diversity and distribution (e.g. altitude, plant communities, soil texture, seasonal variations, light and canopy cover, the composition of assemblage differs between areas, contributing to high overall anuran species richness and high species turn over between sites (Keller *et al*., 2009). Several studies have identified environmental parameters that most likely predict the geographical distribution of species within that broad scale (Amphibians ark, 2012; Onadeko, 2016). However, other microhabitat conditions may produce further structuring of the species distribution. A number of studies have demonstrated that species composition and abundance of leaf-litter amphibians can be influenced by a variety of environmental factors which correlate with anura richness and abundance. It is evident that within environments suitable for anuran habitation, the greatest richness exists in areas of climatic stability, which in turn supports high habitat heterogeneity. Constancy of climatic and vegetation creates a stable environment for animals and allows them to specialize on food and microhabitat, as was demonstrated among three types of habitats in Thailand (Inger & Colwell, 1977).

Amphibian are said to have higher number of globally threatened species than any other group of organisms except flowering plants (Zippel, 2010). Dramatic declines in amphibian populations have been noted since 1980s over the world, and amphibian declines are thus perceived to be one of the most critical threats to global biodiversity (McCallum, 2007). In 2004, the International Union for Conservation of Nature (IUCN) reported that many amphibian species are going into extinction and about 32% are threatened. A Canadian study conducted in 2006, suggested that heavy traffic in their environment was a larger threat to frogs' populations than habitat loss. Some of the amphibians that depend on water at some stage during their life cycle were considered to be threatened. A number of causes are believed to be involved, including habitat destruction and modification, over-exploitation, pollution, introduced species, climate change, endocrine-disrupting pollutants, destruction of the ozone layer (ultraviolet radiation has shown to be especially damaging to the skin, eyes, and eggs of amphibians), leading to extinction of the species. Commercial agriculture is seen as one of the principal agents of habitat loss through deforestation and forest degradation in many countries of the world (Adu *et al*., 2012). However, many of the causes of amphibian declines are still poorly understood, and are a topic of ongoing discussion. The food and agriculture organization (FAO, 2010) estimated that between 2000 -2010, 3million hectares of the world tropical forest were destroyed. In many terrestrial ecosystems, they constitute one of the largest parts of the vertebrate biomass. Dramatic urban development may be responsible for the decline and disappearance of these anura species. Any decline in amphibian numbers will affect the patterns of predation. The loss of carnivorous species near the top of the food chain will upset the delicate ecosystem balance and may cause dramatic increases in opportunistic species. Predators that feed on amphibians are affected by their decline. The western terrestrial garter snake (*Thamnophis elegans*) in California is largely aquatic and depends heavily on two species of frog as source of food that are decreasing in numbers, the Yosemite toad (*Bufo canorus*) and the mountain yellow-legged frog (*Rana muscosa*), putting the snake's future at risk. If the snake were to become scarce, this would affect birds of prey and other predators that feed on it (Jennings *et al*., 1992). Meanwhile, in the ponds and lakes, fewer frogs means, fewer tadpoles. Tadpoles normally play an important role in controlling the growth of algae and also forage on detritus that accumulates as sediment on the bottom. A reduction in the number of tadpoles may lead to an overgrowth of algae, resulting in depletion of oxygen in the water when the algae later die and decompose. Aquatic invertebrates and fish might then die and there would be unpredictable ecological consequences (Stebbins &Cohen, 1995). Therefore, the need for conservation of amphibians cannot be over emphasized. The Global Amphibian Assessment reported declines in the status and abundance of anuran species. Documenting these statistics has created awareness, and investigations are being conducted on the distribution, ecology, causes of decline and environmental context of anurans. A global strategy to help reduced the decline was released in 2005 in the form of the Amphibian Conservation Action Plan. The goal of these investigations is to conserve and restore anuran populations (IUCN, 2006). The world Association of Zoos and Aquariums named 2008 as "the year of the frog" in order to draw attention to the conservation issues faced by them. Amphibian Ark is an organization that was formed to implement the ex-situ conservation recommendations of this plan, and they have been working with Zoos and Aquaria around the world, encouraging them to create assurance colonies of threatened amphibians (Amphibian ark, 2012). However, lack of accurate data on anuran distributions, especially for tropical forests where diversity and declines are concentrated (IUCN 2006), presents a challenge to effective conservation and management.

Previous studies have been done on the distribution, diversity and abundance of anura species in three different vegetation type in South Western Nigeria (Onadeko, 2016). To the best of our knowledge no study has been done on the diversity and abundance of anura species in Lokoja, Kogi State. This study aimed at providing baseline information on species diversity and composition of Anurans in Lokoja. This information will be useful in any conservation strategies of government and other concerned agencies.

2.0 MATERIALS AND METHODS

2.1 Study Area

The study was conducted in Lokoja, Kogi state, Nigeria. Kogi is the confluence state where the two major rivers in Nigeria meet. Although, the area has been inhabited for thousands of years, present settlement at Lokoja was established in 1857. Lokoja has Latitude of $07^{0}49'$ N and Longitude of $06^{0}45'$E and altitude of 45-125m on the Western bank of the River Niger close to its confluence with the River Benue. Figure 1 is the map of Nigerian showing Kogi State and the sampling points.

Vol. 3, No 1 June 2020
ISSN: 2016-1303 | ***Web:*** *www.cjpas.fulokoja.edu.ng*

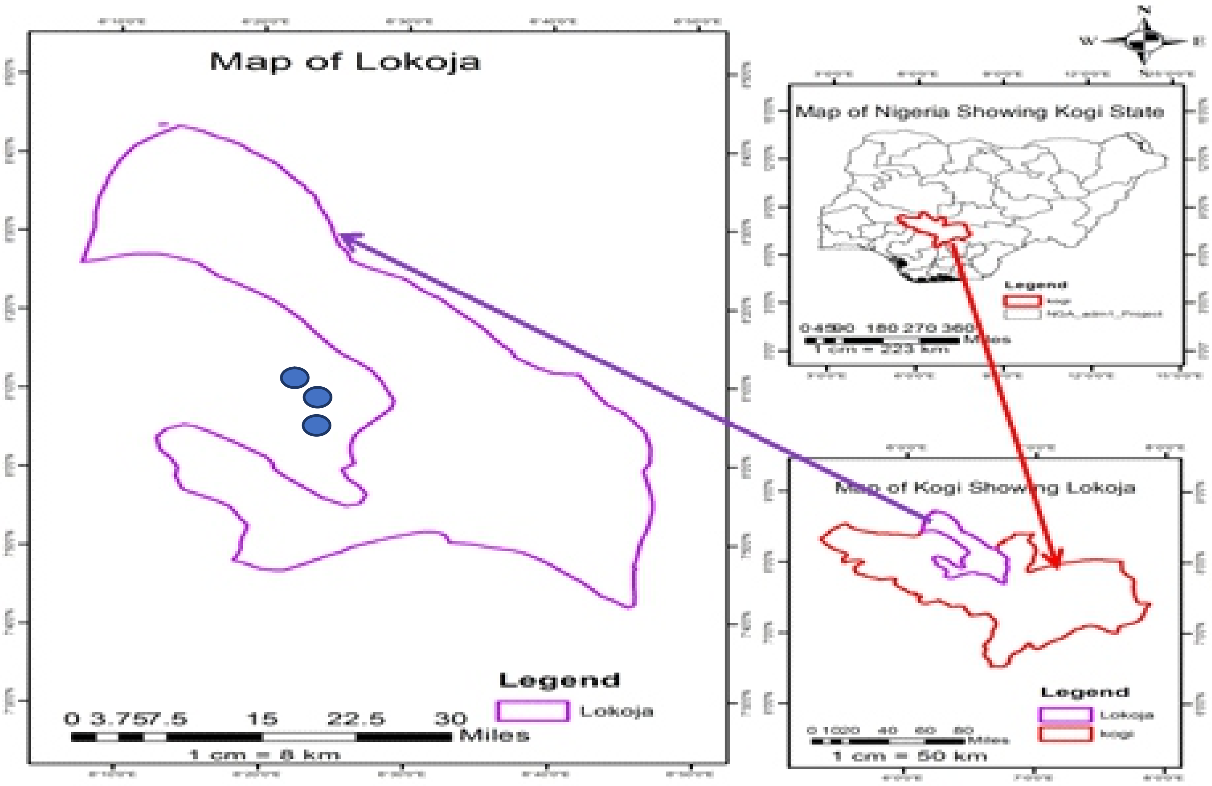

Figure 1: Map of the Study A rea showing the Sampling Locations

2.2 Sampling Techniques

The study was conducted for 6 months; February-April for the dry season months and May- July 2018 for rainy season. The survey was carried out every other day within a week for each month.

2.3 Survey Methods

The methods used for the collection of data for the survey of anura diversity and abundance was the night transect virtual survey and the active search survey methods (Howell, 2004). Transect method involve measuring 100 meters length and 5 meters width at either side of transect. The night transect was chosen because dusk and dawn are the times when most frog are active (Inger, 2005). The same transect were not surveyed on consecutive days, in other to ensure independence of sample. For effective sampling, the line transect were searched more than once during each day survey to find all the species that occurred in the study area (Heyer *et al.,* 1994). Active search survey method was carried out during the survey, it was done outside transect. It involves systematic searching for anura and scanning the vegetation ground and suspected refuges and hideouts such as leaf liters, over logs, debris, rocks and overhanging aquatic environments. There was careful of broad-leaved hydrophytes that harbored arboreal species.

2.4 Handling of Captured Anurans

Any anura captured was identified. The species name, number of species, family name, habitat type, presence and absence of water body were recorded on a sheet of paper used for data analysis. Photograph of each of the species encountered were taken. To avoid double counting, and to ensure effective method for accurate estimating population size, marked released method was used (Hill, 2005). A red thread was tied to the leg of each individual encountered and were released back. Toe clipping methods was not used because it may reduce frog survival rate (May, 2004). Identification was done by comparing captured anurans with identification keys of Inger (2005).

Unidentified individuals were taken to the museum for proper identification by taxonomic experts. Representative specimen of each species was preserved in 10% formalin as museum specimen.

2.4 Data Analysis

2.4.1 Species Richness and Abundance

The number of species recorded represents the species richness, while the total number of individuals represents the abundance.

Relative abundance (RA) = (N/T) × 100---- (1).

Where:

N=Number of individuals of a particular species

T= Total number of individual present.

2.4.2 Species Diversity

The following diversity indices were computed.

I. Shannon-Wiener Index of diversity, (H') - used to compare diversity of species between habitat. $H' = -\sum(P^i \ln p^i)$

Where H' is the index of species diversity, S is the number of anura species, p^i is the proportion of the total number belonging to the i^{th} species and in natural logarithm.

Species richness was assumed as the total number of species encountered.

ii. Evenness was calculated to compare the evenness of distribution between the locations

Evenness/ Equitability $= H^I/\mathrm{Log}S$

3.0 RESULTS

3.1 Amphibian Species Richness and Abundance

A total of 901 individuals belonging to three families with three species were encountered and recordedduring the study. The species encountered were *Sclerophrys maculata*, *Hoplobatrachus occipitalis* and *Ptychadena mascareniensis*. Plate 1, shows the pictorial representation of anuran species encountered in the study. Among the species encountered the highest number belonged to *Sclerophrys maculata* with 603 individuals. The lowest in number was *Ptychadena mascareniensis* with 71 individuals (Table 1). There were more individuals in the wet season than in the dry season (190 and 711 individuals respectively). The anuran species encountered were seen to be utilizing five different habitats namely, human settlement, water bodies, grassland, open habitat and riparian forest (Table 2). The highest number of individuals were found in the riparian forest with 335 individuals, water body accounted for 215 while the lowest occurred in open habitat with 41 individuals. Species richness was high in both riparian forests, grassland, human settlement and water body with 3 species each compare to open habitat with 2 species (Table 2). Anuran species diversity did not differ between Water body (H́ 0.85), human settlement (H́ =0.78) and the grassland (H́ 0.81). However, these three habitats differ with the open habitat which had the lowest species diversity index of H́ 0.36. The evenness of distribution was highest in the water body with 0.77 evenness and was least in the riparian forest with 0.51 evenness. Comparing the evenness among habitats shows that the anurans were evenly distributed in all the habitat since the value were all above 0.5

Table 1: Anuran Species encountered in Lokoja Kogi State

Family	Species	No. encountered		Total	Rel. Abundance (%)
		Dry season	Wet season		
Dicroglossidae	*Hoplobatrachus occipitalis*	58	142	200	22.2
Bufonidae	*Sclerophrys muculata*	120	510	630	69.9
Ptychadenidae	*Ptychadena mascareniensis*	12	59	71	7.88
Total		190	711	901	100
Shannon Diversity index		0.8269	0. 7666		
Evenness		0.7671	0.7175		

Table 2: Anuran species composition and abundance in the different h abitat types

Species	Riparian Forest	Grassland	Human settlement	Water body	Open habitat	**Total**
Hoplobatrachus occipitalis	35	55	10	100	0	**200**
Sclerophrys muculata	335	145	56	58	36	**630**
Ptychadena mascareniensis	30	15	11	10	5	**71**
Total	**400**	**215**	**77**	**168**	**41**	**901**
Shannon Diversity index	0.56	0.81	0.78	0.85	0.36	
Evenness	0.51	0.74	0.72	0.77	0.72	

Plate 1: Dsplay of Anuran Species Encountered in the Survey
Plate 1A: *Sclerophrys maculata* B: *Hoplobatrachus occipitalis:*C *Ptychadena mascarenensis*

Vol. 3, No 1 June 2020
ISSN: 2016-1303 | ***Web:*** *www.cjpas.fulokoja.edu.ng*

4.0 DISCUSSION

4.1 Species Abundance

Among the three species recorded, *Sclerophrys maculata* was the most abundant accounting for 69.9% of total capture and most individuals were encountered in riparian forest. The high relative abundance of *Sclerophrys maculata* may be due to its classification as an adaptable species occurring in wide variety of savanna, grassland and riparian forest. The breeding biology of *Sclerophrys maculata* also favoured its abundance in Lokoja. It is regarded as abundant species with large breeding assemblage.) It breeds in semi permanent and permanent water of humid environment and also breeds by larval development in rivers and streams.

This could be the reason why it was found to occur in all habitat types and it is known as a habitat generalist. The second most abundant was *Hoplobatrachus occipitalis* species which is a water dwelling species, according to Spieler and Linsenmair (1998). This frog stay mainly on water. It inhabits river banks, rock pools and savanna ponds. This frog apparently colonizing any water body. But in dry season, *Hoplobatrachus occipitalis* apparently concentrate on the river banks seeking refuge under overhanging trees in thick bush, in caves, under stones and in rock crevices. This may be the reason why smaller frogs had to settle in marginal habitat such as the rocky river banks as soon as the shallow rock pools and puddles near the banks are filled with water after rainfall. *Ptychadena mascareniensis* is recorded to be the least abundant. However, according to IUCN (2013) this species are abundant and widely distributed. This species were less encountered due to their specific ecological habitat requirement, cryptic habitat and reduced activity pattern. This would have resulted to it been least in abundant.

4.2 Distribution

Not all the anuran species are widely distributed, only some are seen to occur in all habitats. Many habitat types may occur within an area but anuran may utilize a few of these. The number of individuals that represent each habitat may vary from place to place depending on the amount of rainfall, availability of habitat and human interference (Daniel, 1992). *Sclerophrys maculata* and *Ptychadena mascareniensis* were seen in the entire habitat. Riparian forest showed a high number of anuran species abundance which may be attributed to the presence of water body and grasses with leaf litters which help in providing ecological requirement, and breeding, leading to the abundance of anuran species. Also, understory vegetation in riparian forest has been found to be important to frogs providing them with moisture, shelter and calling site (Ficetola *et al*., 2009). It is also important in maintaining the structural and physiochemical characteristics of aquatic environment hence they are important factors that determines community composition (Gomi *et al*., 2006). It provides connectivity between forest patches and facilitates gene flow between amphibians (Richard- Zawacki, 2009). All these factors could have contributed to the riparian forest having more species than other habitat. The removal of riparian forest can result in physical and structural changes of the habitat, and this change causes a shift in anuran species composition (Olson *et al*., 2007). Also a high number of anuran species were observed in the grassland, which experience low temperature due to tree canopies which prevent the reflection of sunlight thereby providing cool ecological environmental conditions for anuran species. The lowest number of species were recorded in open habitat which may result to some factors as anurans relay on different conditions to survive. The size of anuran is controlled mainly by the availability of water for reproduction as food is not a limiting resource in most years (Barbault, 1974), Because anurans needs water for reproduction this may have adversely affected the number of species recorded in open habitat. The decrease in the availability of water in the environment reduces the chance of amphibian to survive in it (Araujo *et al*., 2006). Drier upland areas with lower ponds have lower population of anurans than lowland areas with ponds (Barbulit, 1972). Also the removal of leaf liter directly or indirectly affect anurans (Zou *et al.,* 1995). Many field studies by numerous investigators have shown that ambient level of radiation from the sun decreases the hatching success of some amphibian species in their natural oviposition sites (Blausteir *et al*., 2001). Due to destruction of forest canopy in open habitat, more UVB rays increases and could damage the primary producers of ecosystem such as phytoplankton which is a nitrogen consumer. The UVB affect this process such as the uptake of ammonia and nitrite (Hader *et al*, 1998). This damage to the key producer may increase the availability of reactive nitrogen to ammonia and there could also be significant reduction in availability of food for anuran if UBV damages the plankton (Maicas *et al*., 2007). This may have led to the open habitat been least in distribution of anuran species.

5.0 CONCLUSION

Conditions such as climate of a region, has an effect on the vegetation structure, hence on the community structure, diversity and abundance of anuran species. Anthropogenic activities such as deforestation, urbanization have detrimental effect on natural vegetation which in turn has effect on the anuran species inhabiting such areas leading to the reduction in the diversity and species richness of anuran. The removal of riparian forest habitat can result in physical and structural changes of the habitat, and this change causes a shift in anuran species composition (Olson *et al*., 2007), likewise other habitat. We therefor recommend that, water body, grassland, riparian forest and human settlement should be conserved equally as each habitat support a particular species thereby enhancing their survival, breeding rate and reproduction. Other methods such as drift, net, acoustic survey should be employed in future research which may enable more accurate diversity and abundance of anuran species.

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