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Abundance and Seasonality of Phytoplankton, Zooplankton and Anuran Species in Selected Wetlands of Kogi State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author GUA designed the study, carried out the field and the laboratory analyses of the study with the help of author ICO. Author JCO performed the statistical analysis, wrote and proof-read the manuscript. Authors OPO, JCO, CAI and IJ managed the literature searches and wrote the protocols. All authors thoroughly proof read and approved the final manuscript.

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ABSTRACT

Phytoplankton, Zooplankton and anurans play vital role in the working of wetland ecosystems as they form its dynamic food web. This study was designed to determine the abundance and seasonality of Phytoplankton, Zooplankton and Anuran species in selected wetlands of Kogi State, Nigeria. The study was performed in Abu'ja wetland in Dekina Local Government area and Egwubi seasonal wetland in Ejule, Ofu Local Government area of Kogi state. From each sampled wetlands

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planktons were collected with plankton net at the sites. Overall, 854 specimens of anurans, 584 from Abu'ja and 270 from Egwubi sites were collected within a period of eighteen months. The abundance of phytoplankton, zooplankton and anuran species were computed. Abundance was computed as a proportion of numbers of organisms in a group to the summation of the total number in all the groups being considered. Simpson's index (Dominance), Gini-Simpson's, Shannon-Wiener index, Berger-Parker index, Margalef's index, Menhinick's index, Fisher alpha, Equitability index, Brillouin index and Chao index were all calculated following standard methods. The data collected was analyzed using the Statistical Package for Social Sciences (SPSS) version 20.0, PAST version 3.14 and Microsoft Office. Level of significance was $p < 0.05$. Anuran species found in both wetlands included *Amietophrymus regularis*, *A. maculatus* and *Hoplobatracchus occipitalis*. Phytoplankton species encountered in both study stations include *Oscilatoria spp*, *Anabaenia spp*, *Anacystis spp*, *Spirogyra spp, Oedogonium spp*, *Savicular spp* and *Euglena spp*. Zooplanktons encountered include *Epiphanes spp*, *Philodina spp*, *Synchata spp*, *Poliathra spp*, *Holopedium spp*, *Daphnia spp*, *Alona spp* and *Bosmina spp*. The abundance and seasonality of phytoplankton, zooplankton and anurans in the selected wetlands studied in Kogi state, Nigeria showed that the organisms abundance are highly influenced by the seasons in Kogi State, with its peak abundance in rainy season and very low abundance in dry season.

Keywords: Abundance; seasonality; anuran; phytoplankton; zooplankton wetlands; Kogi state.

1. INTRODUCTION

Phytoplankton, zooplankton and anurans play essential role in the working of wetland ecosystems as they make up its dynamic food web. Intensive farming practices cause changes in wetland water quality, soils and vegetation condition [1]. The major anthropogenic factors that have contributed to wetland variations are: change in area, change in water regime, change in water quality and uncontrolled use of wetland resources [2]. Toads and frogs are similar organism that make up anurans. Many species of frogs have smooth skin and live near water, while toads typically have rough, warty skin and often live in comparatively drier habitats. There is a reduction in anuran population and currently mass extinction of anuran species globally. Since the 1980s, decrease in amphibian populations, including population crashes and mass localized extinctions; have been observed in locations all over the world. These declines are known as one of the most critical threats to global biodiversity and several courses are believed to be involved, including disease, habitat destructio, exploitation, pollution and pesticide use [3]. Like many other organisms, rising ultra-violet B radiation owing to stratospheric ozone depletion and other variables could damage the DNA of amphibians, particularly their eggs [4]. The quantity of damage depends, upon the life stage and environmental variables.. Exposure to ultraviolet radiation may not kill a particular species or life stage but may cause sub-lethal damage. Anthropogenic climate alteration may likely exerted a key effect on amphibian reduction. Phytoplankton is a vital primary producer, since it is the starting point of the whole food chain in wetlands. [5] stated that the highest production of phytoplankton is gotten when the physico-chemical factors are at optimum. Species make up of phytoplankton community is a proficient bio-indicator for water quality [6]. The Chlorophyta, Cyanophyta and Bacillariophyta make up the three main groups of algae in wetland ecosystems. Nutrient variations and water quality usually affect the algal distribution [7-8]. Nevertheless, some researchers have used floating phytoplankton as biological indicators for lenthic lakes [9-11]. This study was designed to determine the abundance and seasonality of phytoplankton, zooplankton and anuran species in selected wetlands of Kogi State, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

The study was performed in Abu'ja wetland in Dekina Local Government area and Egwubi seasonal wetland in Ejule, Ofu Local Government area of Kogi State. Kogi east has tropical hinterland type of climate, with high temperatures of 27 ^{0}C – 30 ^{0}C. The highest temperature is gotten between the period of March and April, while the lowest temperature is gotten between the period of December and January. The annual rainfall is 100 -150cm, with interval of six to eight months. The relative humidity is elevated during the rainy season; this is about 80% during this period; whereas the relative humidity is small during the dry season,

as small as about 5%. The dry season lasts for about five to six months. The atmosphere is frequently cloudy during rainy season, as different from dryness and dust in dry season. The climatic circumstances of the study area and the period of rain (between 6-8 months) described favors the flourishing of anuran, phytoplankton and zooplankton species.

2.2 Study Design and Sampling

Anuran samples were randomly collected from the water and surrounding wet grass of the wetlands used to avoid removing excessive number of anuran individuals from same population for conservation reasons. Overall, 854 specimens of anurans were collected within a period of eighteen months [12-13]. A total of 3 sample sites was marked out in each wetland; (site 1), water merging with vegetation (site 2) open water body, and (site 3) vegetation around water, was selected for proper coverage. Each of the areas were visited twice each month during the study period between 8am -11am to collect anurans and collect planktons. Methods implored during the collection process included; Hooks baited with body parts of the anurans, this served as a lure trap for them, Direct chase and capture; this involved the active chase of any spotted frog or toad and Direct light flash: this was implored for night catches. The specimens were transported alive to the laboratory where they were sacrificed with MS 222, commercially available as Tricaine Methane Sulfonate (TMS). Tricaine was buffered with sodium bicarbonate. A 10g/L-1 stock solution was made, and sodium bicarbonate was added to saturation, resulting in a pH between 7.0 and 7.5 for the solution [14].

2.3 Anuran Species Identification

Frogs collected were identified using available keys and taxonomic standards. Anurans were studied in the field and transported to the laboratory in some quantity of water gotten from the wetlands. Frogs collected were grouped according to their various habitats and site of collection and separately analysed. Abundance of phytoplankton, zooplankton and anuran species was computed. Abundance was computed as proportion of numbers of organisms in a group to the summation of the total numbers in all the groups being considered. Simpson's index (Dominance), Gini-Simpson (Simpson's), Shannon-Wiener index, Berger-Parker index, Margalef's index, Menhinick's index, Fisher alpha, Equitability index, Brillouin index and Chao index were all calculated according to [15] and [16]. Brillion's diversity index and Simpson's, index of dominance was employed to calculate each frog species. The formulae used include:

Simpson's index, D = i=$\sum_{i=1}^{S} \mathrm{p2}$

Where p is the proportional abundance of ith species

Gini-Simpson index = 1- D

Shannon-Wienner's index, H' = $-\sum_{i=1}^{S} \mathrm{pLn(p)}$

Where p is the proportional abundance of ith species

Berger – parker index of Dominance, d = NmaxN

N_{max}*= number of individual in the most abundant species. N = total number of individuals in sample*

2.4 Plankton Collection

Planktons were collected with plankton net at the sample site and transported in sterile bottles to the laboratory for identification.

2.5 Data Analysis

The data was analysed using the Statistical Packages for Social Sciences (SPSS) version 20.0, PAST (Paleontological Statistics) version 3.14 and Microsoft Office Excel.

3. RESULT

3.1 Relative Abundance of Phytoplankton, Zooplankton and Anuran Species in Abu'ja and Egwubi

The total number of species collected from the sampling stations is summarized in Table 1. Equal number of species were collected from Ab'uja and Egwubi study stations, three anuran species each, seven phytoplankton species each and eight zooplankton species each were obtained. The species collected were similar in the two stations. Irrespective of the sampling pattern, anurans were the most abundant; relative abundance of *Amietophrymus regularis* was 28.24% and 37.17%, *Amietophrymus maculatus* 18.83% and 19.79% and *Hoplobatracchus occipitalis* 19.29% and 14.17%

at Abu'ja and Egwubi respectively. Phytoplankton species relative abundances were in the ranges 1.5 – 3.5%. Zooplanktons species relative abundances were in the range 1.0 – 3.0. Irrespective of the sampling procedure, the relative abundances of anurans in each of the sampling stations were above 60%. While phytoplankton and zooplankton were each below 20% in both stations Fig. 1. Among the three anuran species, *A.regularis* was the most abundant comprising 43% and 52% of the total anuran species in Ab'uja and Egwubi stations respectively Fig. 2. *A. maculatus* had equal relative abundance 28% to other anuran species in both stations. *H. occipitalis* relative to the two species of anurans already mentioned was 29% and 20% abundant in Ab'uja and Egwubi respectively.

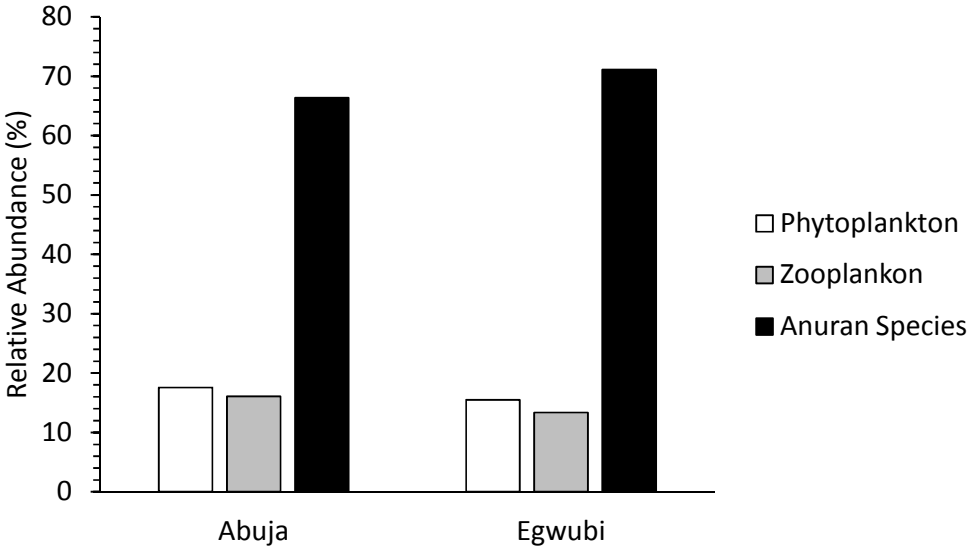

Fig. 1. Relative abundance of phytoplankton, zooplankton and anurans species in Abu'ja and Egwubi

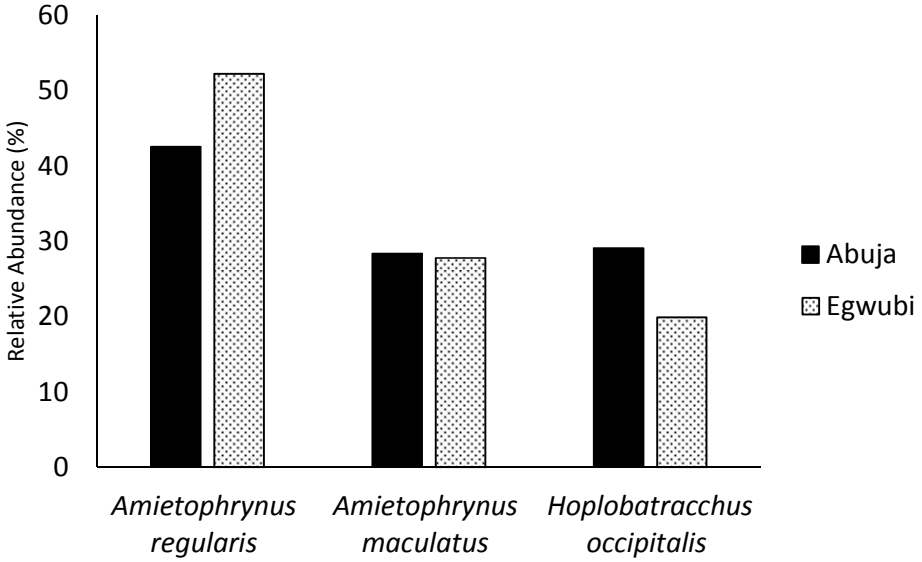

Fig. 2. Relative abundances of anuran species at Ab'uja and Egwubi stations

Table 1. Relative abundance of phytoplankton, zooplankton and anuran species in Abu'ja and Egwubi

		Abu'ja		Egwubi	
Groups	**Species**	**TOTAL**	**Relative Abundance (%)**	**TOTAL**	**Relative Abundance (%)**
Phytoplankton	*Oscillatoria* spp.	22	2.53	13	3.48
	Anabaenia spp.	30	3.44	7	1.87
	Analystis spp.	26	2.99	3	0.80
	Spirogyara spp.	18	2.07	15	4.01
	Oedogonium spp.	15	1.72	5	1.34
	Savicular spp.	21	2.41	7	1.87
	Euglena spp.	21	2.41	8	2.14
Zooplankon	*Epiphanes* spp.	25	2.87	7	1.87
	Philodina spp.	24	2.76	11	2.94
	Synchata spp.	23	2.64	4	1.07
	Poliathra spp.	17	1.95	4	1.07
	Holopedium spp.	12	1.38	2	0.53
	Daphnia spp.	16	1.84	11	2.94
	Alona spp.	14	1.61	6	1.60
	Bosmina spp.	9	1.03	5	1.34
Anuran Species	*Amietophrynus regularis*	252	28.24	139	37.17
	Amietophrynus maculatus	164	18.83	78	19.79
	Hoplobatracchus occipitalis	168	19.29	53	14.17
	TOTAL	578	100	270	100

Among the phytoplankton species in Abu'ja station, *Anabaenia* spp. was the most abundant (19%) while *Oedogonium* spp. (10%) was the least abundant. *Anacystis* spp. was the second most abundant species at 17%. *Oscillatoria* spp., *Savicular* spp. and *Euglena* spp. were each 14% abundant Fig. 3A. Among the zooplanktons, *Epiphanes* spp. was the most abundant (18%) closely followed by *Philodina* spp. (17%) and *Synchata* spp. (16%). The least abundant zooplankton was *Bosmina* spp. (6%, Fig. 3B).

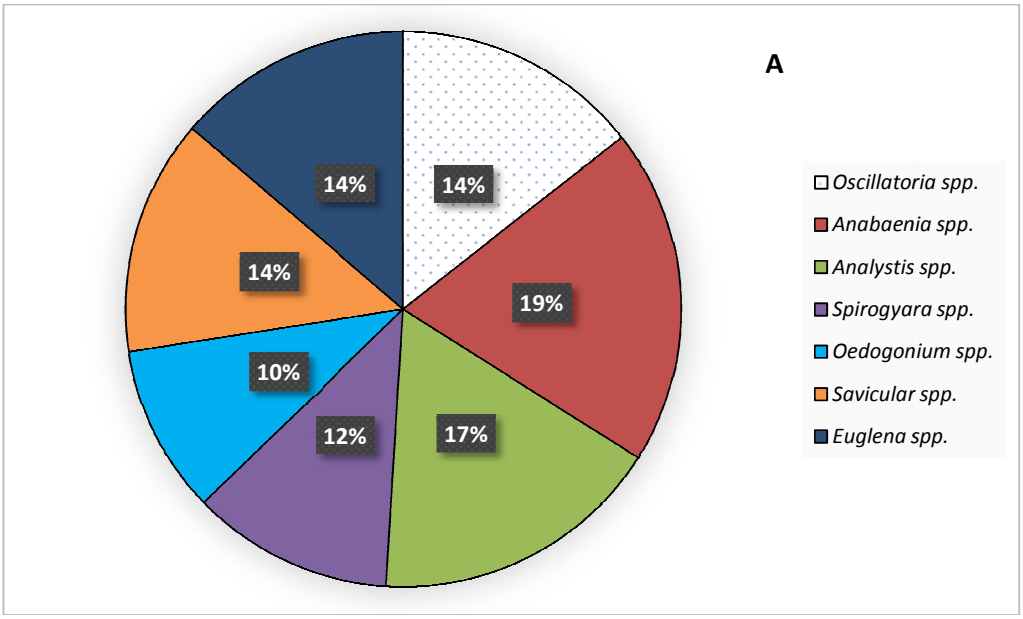

Fig. 3A. Relative abundances of species of phytoplanktons in Abuja station (abundance of each phytoplankton species relative to other phytoplankton)

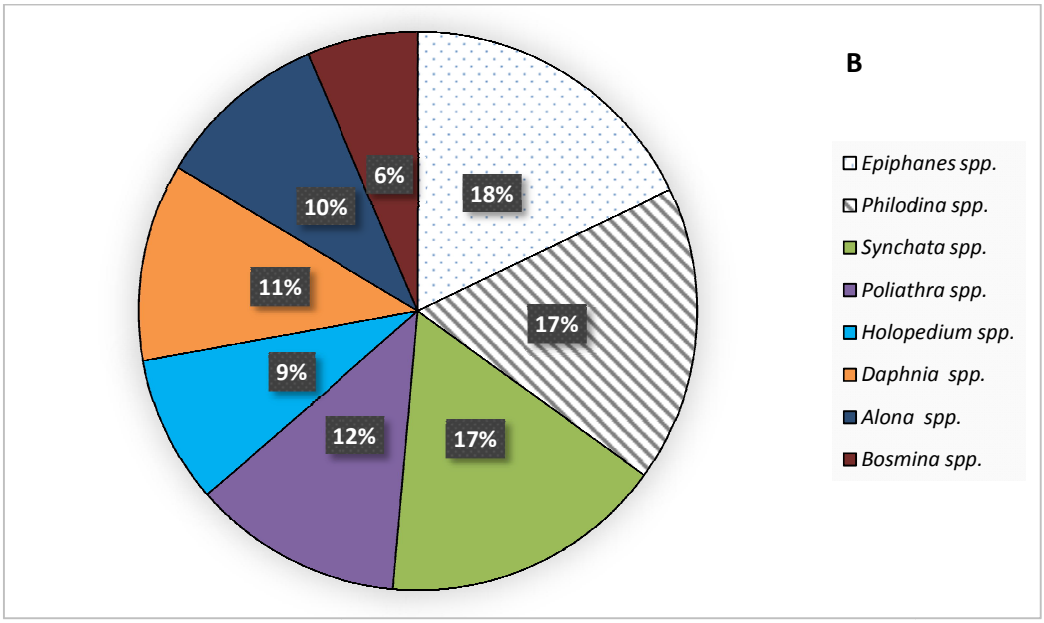

Fig. 3B. Relative abundances of species of zooplanktons in Abuja station (abundance of each zooplankton species relative to other zooplankton)

Among the phytoplankton species at Egwubi station, *Spirogyra* spp. was the most abundant (26%) followed by *Oscillatoria* spp. (22%). The least abundant was *Anacystis* spp. (5%) *Euglena* spp., *Anabaenia* spp. and *Savicular* spp. were 14%, 12% and 12% abundant Fig.4A. Among the zooplankton species at Egwubi station, *Philodina* spp. and *Dapnia* spp. were the most abundant (22% each), followed from a distance by *Epiphanes* spp. (14%) and *Alona* spp. (12%). The least abundant zooplankton at the station was *Holopedium* spp. (4%, Fig. 4B).

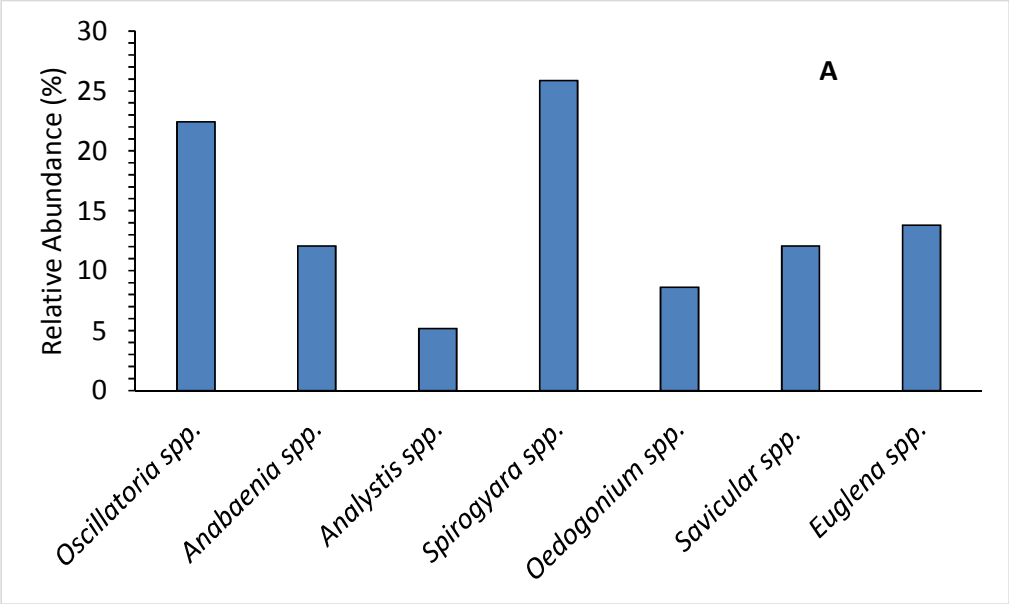

Fig. 4A. Relative abundances of species of phytoplanktons in Egwubi station (Abundance of each phytoplankton species relative to other phytoplankton)

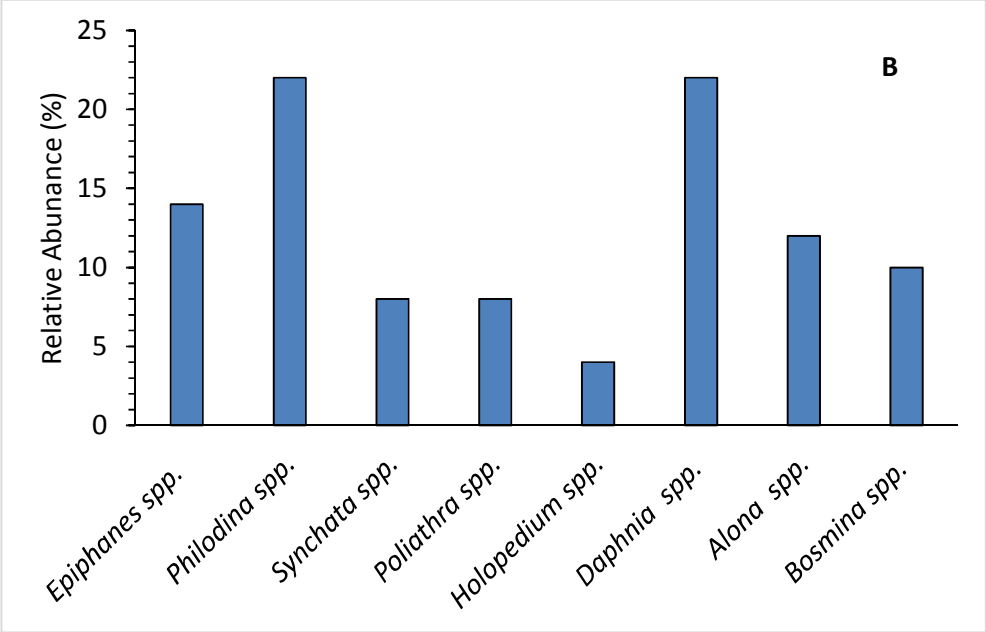

Fig. 4B. Relative abundances of species of zooplanktons in Egwubi station (abundance of each zooplankton species relative to other zooplankton)

3.2 Overall Monthly Abundance of Species in Ab'uja and Egwubi Stations

The months of peak abundance of phytoplankton, zooplankton and anuran abundance in both sampled stations were between July and November. Species abundance was generally lowest in the dry season months of December, January, February and March, though no sample was collected in the months of January and February at Egwubi station (Fig. 5A, B).

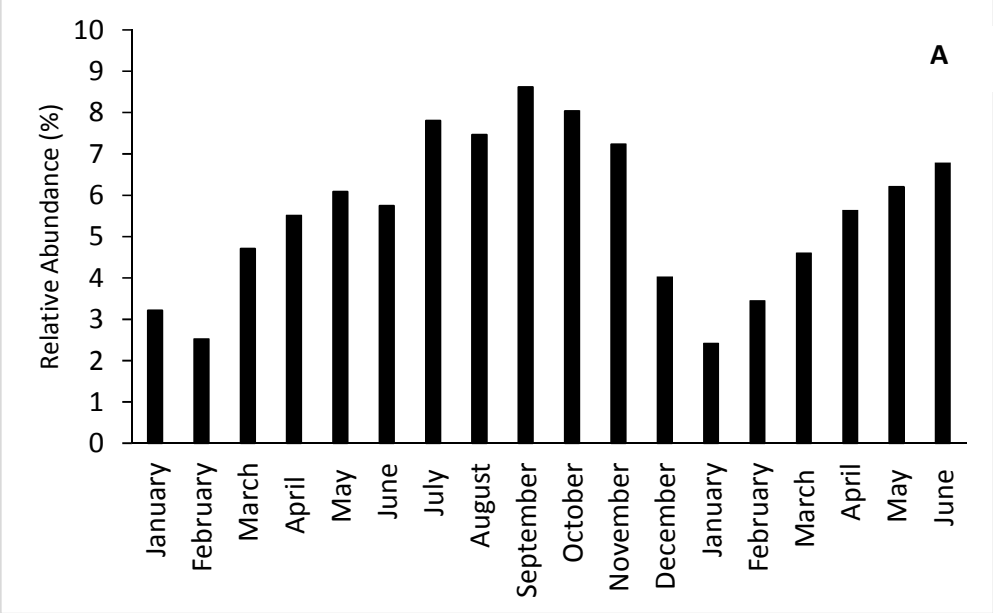

Fig. 5A. Monthly relative abundance of phytoplankton, zooplankton and anurans in Ab'uja and Egwubi station from January 2017 to June 2018 in Ab'uja

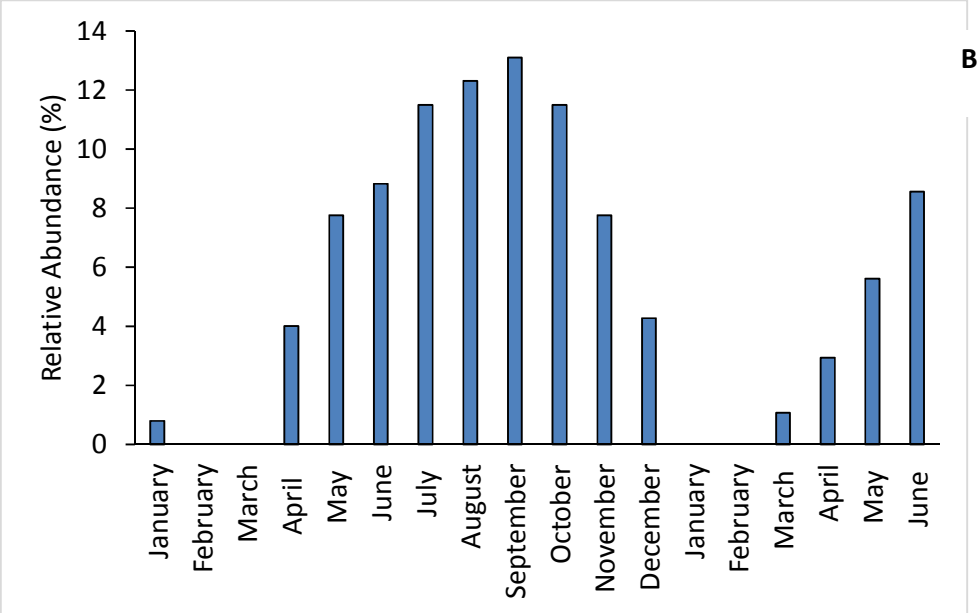

Fig. 5B. Monthly relative abundance of phytoplankton, zooplankton and anurans in Ab'uja and Egwubi station from January 2017 to June 2018 in Egwubi

4. DISCUSSION

From the result obtained, anurans were the most abundant species with 28% and 37.1% for *Amietophrynus regularis,* 18.83% and 19.79 % for *Amietophrynus maculata* and 19.29% and 14.17 for *Hoplobatracchus ocipitalis* at Abu'ja and Egwubi stations respectively. This is in line with the reports of [17], which stated that the order Anura constitute the vast majority (88%) of living species of amphibians. This result showed that the relative abundance of anurans in each of the sampling stations were above 60%. Among the three species of Anurans, *Amietophrynus regularis* was the most abundant with 43 % and 52% of the total number of anurans species in Abuja and Egwubi wetlands respectively. The differences in abundance may be due to variation in water quality [18]. *A. maculatus* has equal abundance 28% to others in both study stations. *H occipitalis* has 29% and 20% abundance in Abu'ja and Egwubi study stations. The anurans species found in Abu'ja and Egwubi were *Amietophrymus regularis, Amietophrymus maculate,* and *Hoplobatocchus occipitalis.* This is opposed to the result of [19], which reported on the *Amietophrymus regularis* alone. This difference was because their work was on samples obtained from within Anyigba community different from our work station. The three species are common toads but distinguished by size and colours, and discs on the tips of their toes, a morphological adaptation that assists in the vertical movement. [20]. The variation in phytoplankton abundance in Abu,ja and Egwubi wetlands may be due to difference in water quality of the two sampling locations, duration of water in the wetlands and adjoining vegetation of the wetlands [18].

Pertaining to seasonal conditions, it was observed that frogs thrive in conditions where there is higher rainfall, more humid conditions. Higher number of frogs was observed in the wet months, the peak was in September when many cycles of metamorphoses must have been completed. This result is in agreement with the report of [17] however during dry season these condition are not available thereby, significantly reducing their number, [21] has observed similar trend in the forest swamp of the river Niger delta south-eastern Nigeria, greater number of anuran species and individuals were captured in the rainy season than the dry season. During the dry season some frogs move away from temporary pools of water that would have dried and become restricted to large and permanent bodies of water. Some hibernate under leaves of the forest floor and others in the moody substrate of the temporal wetlands. The monthly abundance of phytoplankton and zooplankton follow the same pattern as anuran species. Planktons were most abundant in the rainy season months, with the peak in September. In Egwubi wetland no species was found in the Dry season months of January and February 2016 and February and March 2017, because there was no water in the pond to sustain their lives. This is in line with the observation of [22] that species abundance has direct relation between the seasonal bimodal rainfall pattern, the environment and the bimodal gradient in the Lagos Lagoon. They are widespread in the tropics, especially in savannas mountains grassland, forest and are beneficial animals to have in the home garden, as well as on farm. Toads play role in nutrient cycles and as environmental indicators, nutrient are recycled from aquatic systems to terrestrial when toads enter the land after metamorphosis. Tadpoles, the swimming larval forms of toads and frogs that hatch from the fertilised eggs in the water, are important food source for fish and other aquatics organisms.

5. CONCLUSION

The abundance and seasonality of anurans, phytoplankton and zooplankton in the selected wetlands studied in Kogi state, Nigeria showed that the organisms abundance are highly influenced by the seasons in Kogi State, with its peak abundance in rainy season and very low abundance in dry season.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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