Planktons as Bio-indicators in Lotic Aquatic Ecosystem of Tungabhadra River near Harihar, Karnataka State, India

Suresh B
Assistant Professor, Department of Civil Engineering,
Bapuji Institute of Engineering and Technology, Davangere – 577004, Karnataka, India

ABSTRACT

Phytoplankton and Zooplankton are plays a significant role and considered as Bioindicators in lotic aquatic ecosystems as they form its healthy food web. Study was considered to appraise the abundance and seasonality of Bioindicators in lotic aquatic ecosystem. The study was performed in Tungabhadra River in near Harihar, Karnataka State, India. From each selected locations in lentic aquatic system planktons were collected with plankton net at the locations. Overall, 854 specimens of anurans, 584 from Station 1 and 2 and 270 from Station 3 and 4 locations were collected within a period of one year. The abundance of phytoplankton and zooplankton species was tabulated. Abundance was identified as amount of numbers of species in a group to the synopsis of the total number in all the groups are considered. Biological indices (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 using standard methods. The species number collected was appraised using the Statistical Package for Social Sciences (SPSS) version 20.0, PAST version 3.14 and Microsoft Office. Level of significance was $p < 0.05$. Bioindicators found in all the selected locations includes Phytoplanktons are *Oscilatoria spp*, *Anabaenia spp*, *Anacystis spp*, *Spirogyra spp*, *Oedogonium spp*, *Savicular spp* and *Euglena spp*. Zooplanktons are *Epiphanes spp*, *Philodina spp*, *Synchata spp*, *Poliathra spp*, *Holopedium spp*, *Daphnia spp*, *Alona spp* and *Bosmina spp*. The abundance and seasonality of bioinficatorss in the selected lotic aquatic ecosystem indicated that the species abundance are highly encouraged due to variations in the climate and weather conditions of the study area, with its peak abundance in rainy season and very low abundance in dry season.

Keywords: Abundance, Seasonality, bio-indicators, lotic, aquatic, Harihar, Karnataka State

1. **INTRODUCTION**

Bio-indicators play essential role in the working of lotic aquatic ecosystems as they make up its systematic food web. Intensive agricultural practices, increasing in the population and industrial activity may cause changes the in the quality of lotic water due to discharge of waste water into the ecosystem [1]. The major man made activities is the chief factors that have extended to lotic water quality variations are: change in physical, chemical and biological properties in water quality and uncontrolled use of water resources [2]. The quantity of changes depends, upon the life condition and ecological variables. Anthropogenic climate alteration may likely utilized a chief effect on species reduction. Phytoplankton is a chief primary tropic level species in most of the aquatic ecosystem especially in lotic aquatic system, since it is the first life of the whole food chain in aquatic ecosystems. [5] Reported that the maximum production of phytoplankton is present when the physico-chemical variables are at standard values. Species make up of abundance of phytoplankton population is a significant bio-indicator for water quality [6]. The Chlorophyta, Cyanophyta and Bacillariophyta are the three chief groups of algae in ecosystems. Changes in the nutrients and water quality generally affect the algal diversity [7, 8]. Nevertheless, some researchers have also mentioned floating phytoplankton as biological indicators for lenthic aquatic systems [9 - 11]. Present study was designed to appraise the abundance and seasonality of bioindicators in lotic aquatic ecosystem near Harihar, Karnataka State, India.

2. MATERIALS AND METHODS

The water and algal samples were collected at regular intervals of 15 days at 4 stations for one year. During the present Investigation four different stations were chosen on the basis of algal occurrence and human activities.

2.1 Study Area

The study was performed in Tungabhadra River near Harihar of Karnataka State. Tungabhadra River in Karnataka is an important tributary of Krishna. It has a drainage area of 71,417 sq.km out of which 57,671 sq.km lies in the state. It covers a distance of 293 km in the state and is getting polluted due to rapid industrial growth, domestic and agricultural activities in the region. Pollution is as old as man himself, in prehistoric time the population was very thin, the man used to move from place to place in search of food and better living. The district Davangere is located in the central part of Karnataka state (India) between latitude 14^{O} 17’ to 14^{O} 35’ N and longitude 75^{O} 50’ to 76^{O} 05’ E covering an area of 6500 sq. km at an average altitude of 540 m above Mean Sea Level (MSL).

The river Tungabhadra is bifurcating the adjoining district namely Haveri. Four strategic locations are selected for the limnological studies of algae from various aquatic habitats of lotic environment of the river have been made as studied extensively in India. Research studies on the Limnological aspects are of great significance in developing resources of a water body. The seasonal variations of physical – chemical factors have a profound effect on the distribution and population density of both fauna and flora (Hassa 1998). The abundance of phytoplankton and zooplankton in the fresh water bodies is greatly regulated by the physico-chemical factors (Muhauser et al 1995). In the present study phytoplankton diversity in Tungabhadra River are reported.

2.2 Study Design and Sampling

Station (S1): The site of this habitat is located at the upstream city before the river enters into city.

Station (S2): This station is located on the main stream of river Tungabhadra in a place just near the confluence point of sulekere stream (Tributary)

Station (S3): This station is located at the downstream of Harihar Polyfibers effluent discharge (near Harlapura).

Station (S4): This sampling station is located about 2 km away from confluence point (S2).

Total 4 sampling locations were selected in Tungabhadra River at a stretch of 30 km for proper coverage. Sampling Physico-chemical analysis of water as per was done according to standard methods recommended by APHA (1995) and Trivedy and Goel (1986). Algae were preserved in 4% formaldehyde for identification using key provided by Smith (1950), Prescott (1978) for Chlorophyceae and Euglenophyceae; Desikachary (1959) for Cyanophyceae and Hendey (1964) for Bacilleriophyceae (Table 6). Statistical analysis Correlation and inter correlation matrices were compared separately for the physico-chemical parameters and phytoplankton (s) (Table 6).

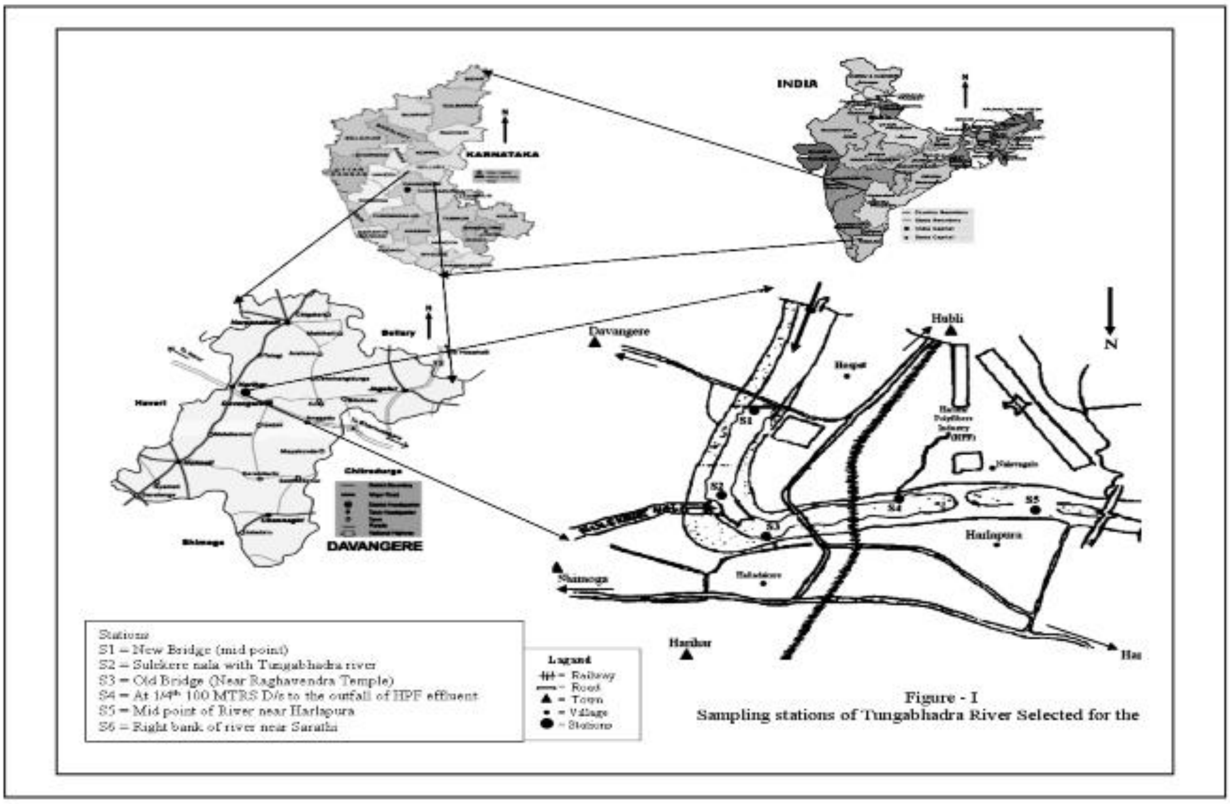

Figure - I
Sampling stations of Tungabhadra River Selected for the

Abundance of phytoplankton and zooplankton species was computed. Abundance was computed as quantity of numbers of species in a group to the synopsis 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 AND DISCUSSION

3.1 Relative abundance of phytoplankton and zooplankton

The total number of species collected from the sampling stations is summarized in Table 1. Equal number of species was collected from Station 1 and Station 4, 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 Station 1 and Station 2 and Station 3 and Station 4 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 (Figure 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 Station 3 and Station 4 respectively (Figure 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 Station 3 and Station 4 respectively.

Table 1: Relative abundance of phytoplankton and zooplankton species

		Location 1 and 2		Location 3 and 4	
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
	TOTAL	578	100	270	100

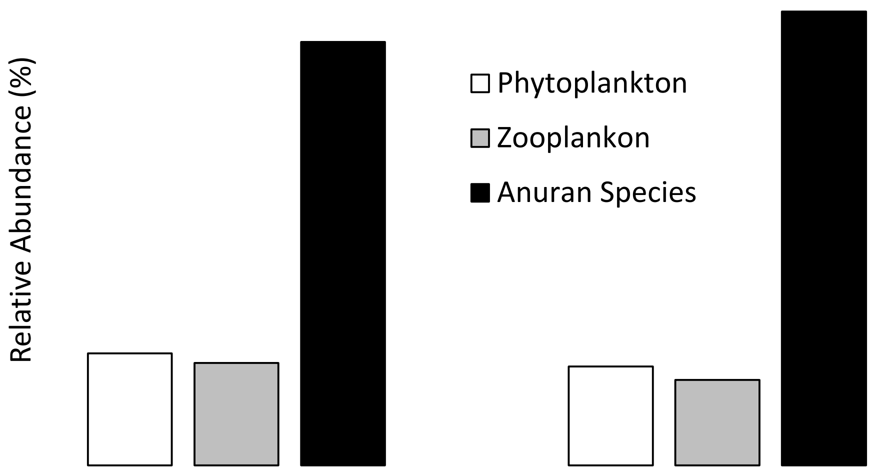

Figure 1: Relative abundance of phytoplankton and zooplankton species

Among the phytoplankton species in Station 1 and Station 2, *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 (Figure 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%, Figure 3B).

Among the phytoplankton species at Station 3 and Station 4, *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 (Figure 4A). Among the zooplankton species at Station 3 and Station 4, *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%, Figure 4B).

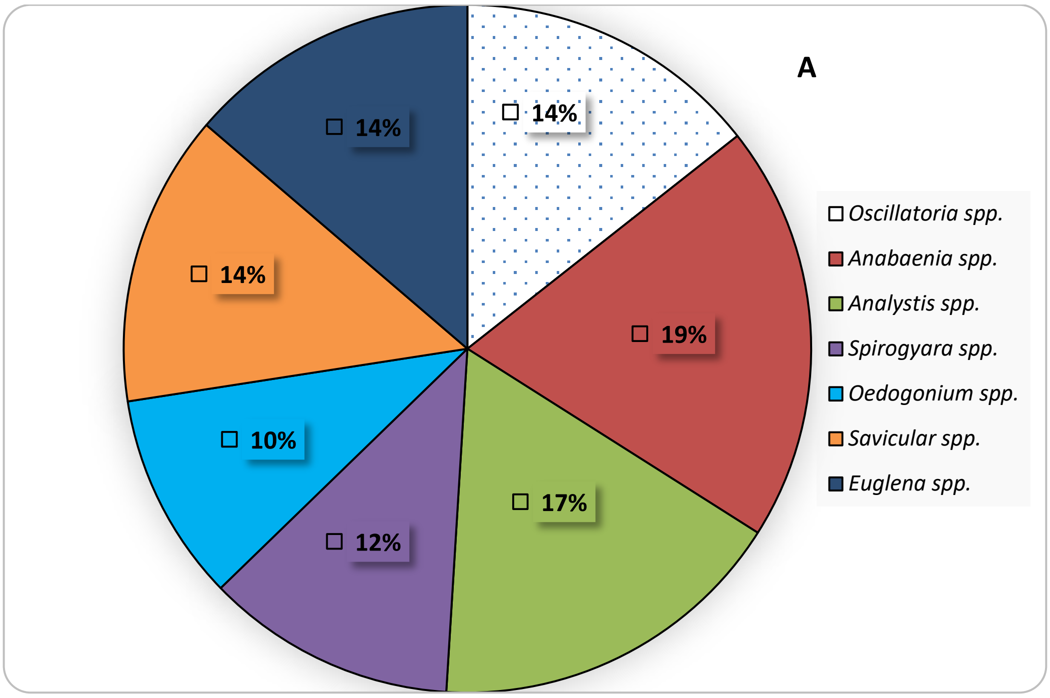

Figure 3A: Relative abundances of species of phytoplanktons in Station 1 and Station 2 (Abundance of each phytoplankton species relative to other phytoplankton).

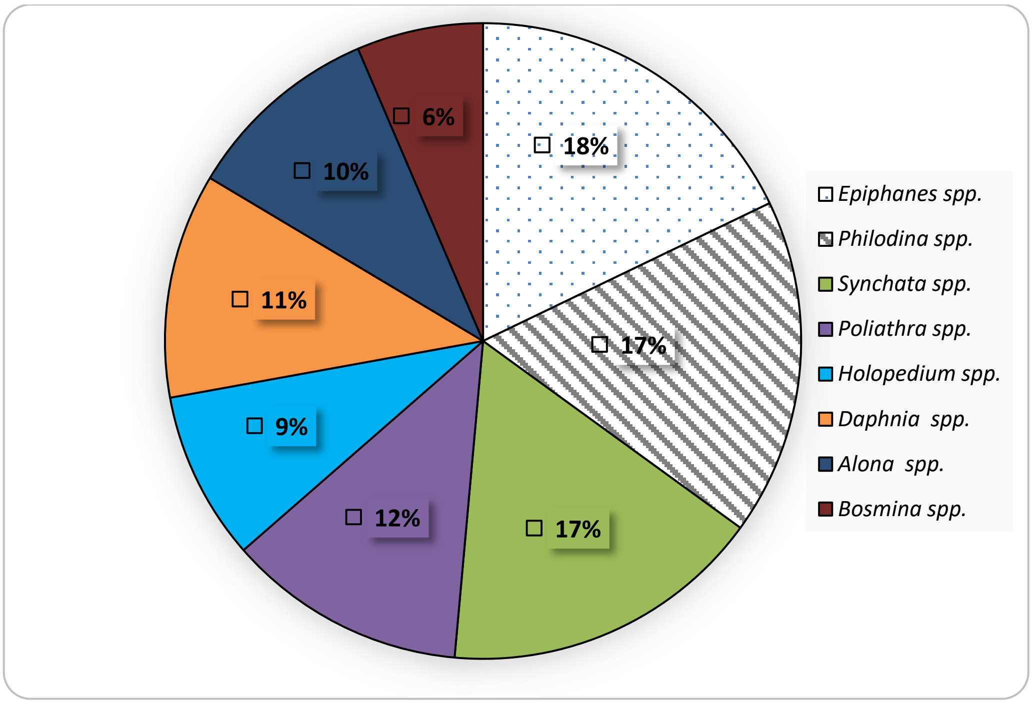

Figure 3B: Relative abundances of species of zooplanktons in Station 1 and Station 2 (Abundance of each zooplankton species relative to other zooplankton).

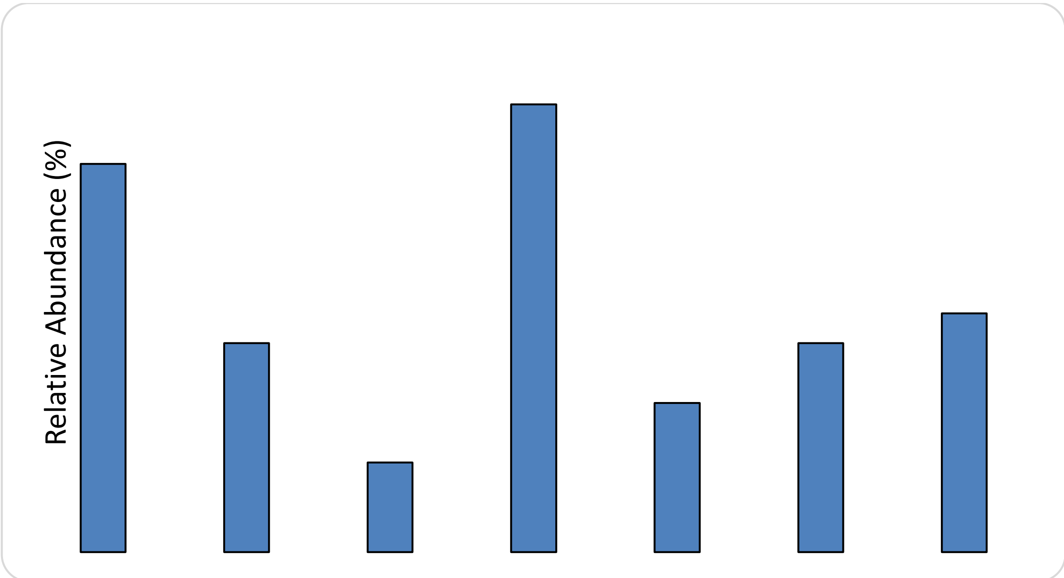

Figure 4A: Relative abundances of species of phytoplanktons in Station 3 and Station 4 (Abundance of each phytoplankton species relative to other phytoplankton)

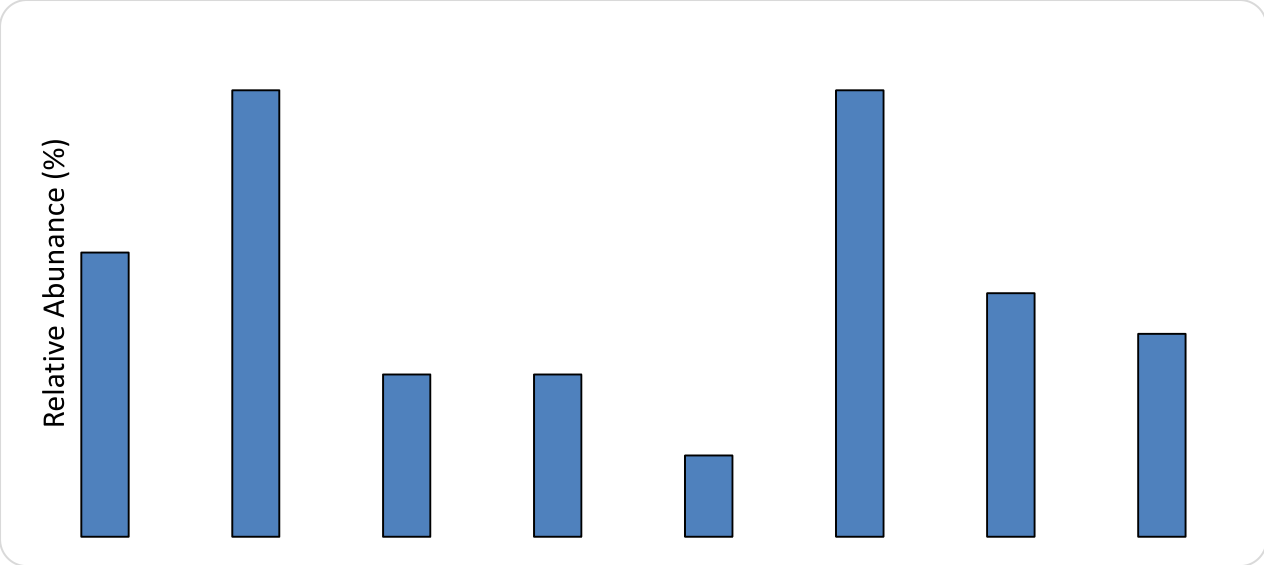

Figure 4B: Relative abundances of species of zooplanktons in Station 3 and Station 4 (Abundance of each zooplankton species relative to other zooplankton).

3.2 Overall Monthly Abundance of Species in Selected Locations

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 Station 3 and Station 4 (Figure 5A, B).

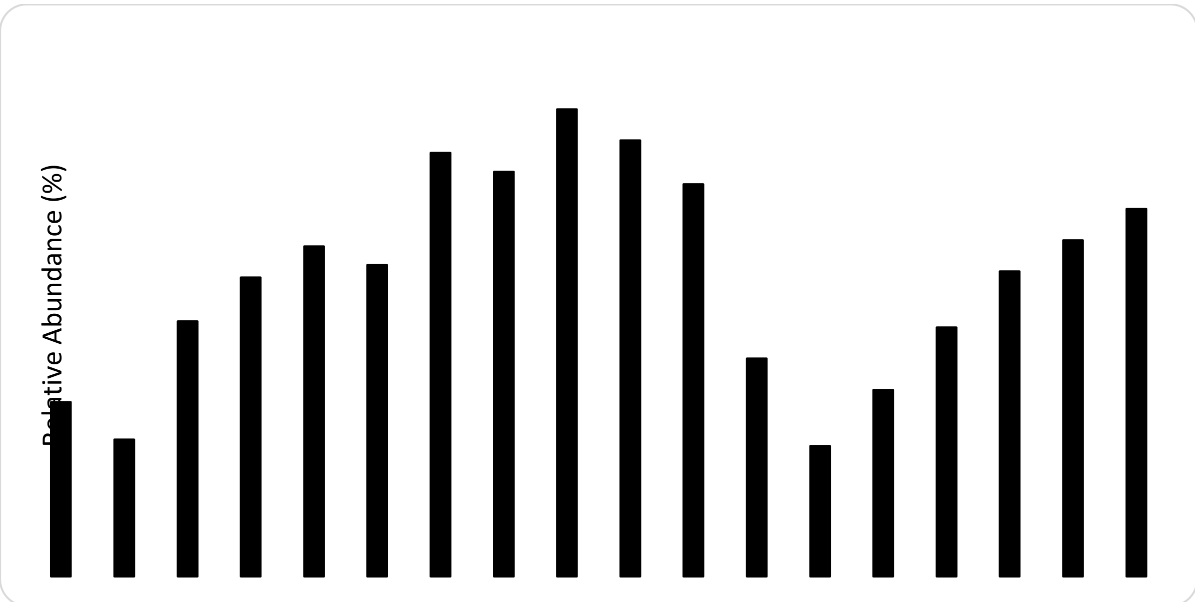

Figure 5A: Monthly relative abundance of phytoplankton and zooplankton in selected locations from January 2021 to June 2022 in Station 1 and Station 2

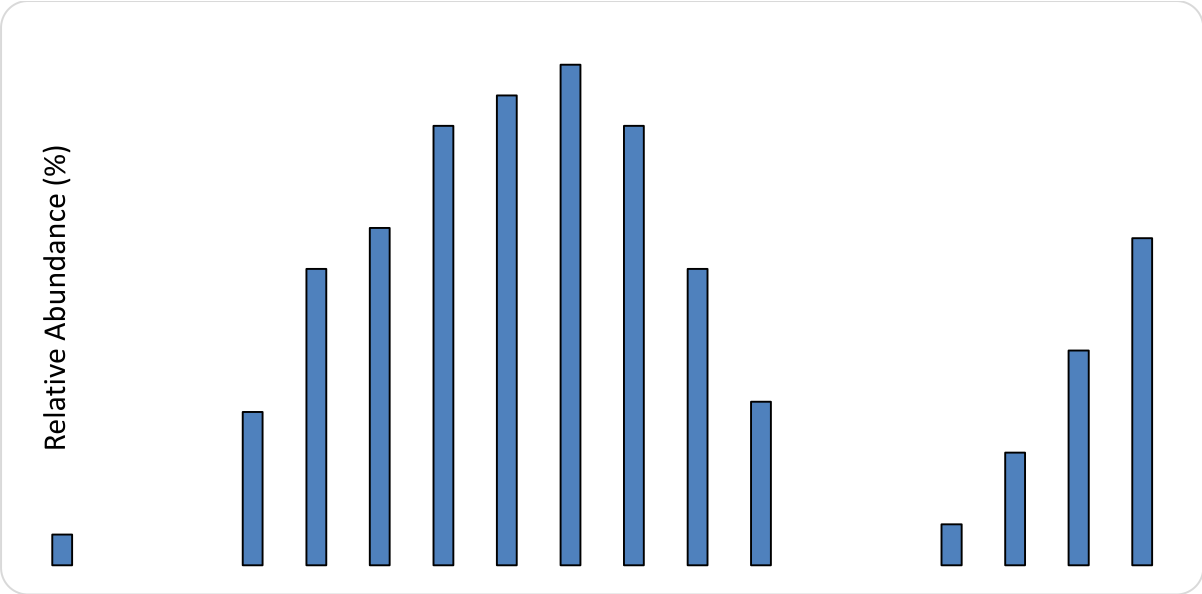

Figure 5B: Monthly relative abundance of phytoplankton and zooplankton in selected locations from January 2021 to June 2022 in Station 3 and Station 4

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 Station 1 and Station 2 and Station 3 and Station 4 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 Station 1 and Station 2 and Station 3 and Station 4 locations 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 Station 1 and Station 2 and Station 3 and Station 4. The anurans species found in Station 1 and Station 2 and Station 3 and Station 4 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 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 Station 3 and Station 4 may be due to difference in water quality of the two sampling locations, duration of water in the river and adjoining vegetation of the river [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 river. 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 Station 3 and Station 4 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, nutrients 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 river locations studied in Karnataka state, Tungabhadra river showed that the organisms abundance are highly influenced by the seasons in Karnataka State, with its peak abundance in rainy season and very low abundance in dry season.

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