Measures of Biodiversity Index of Algal Communities in a Freshwater Ecosystem in Northern Nigeria

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Abstract
The study of the diversity, species richness, and abundance of algae was under taken for the period of eight months (February – September 2007) in Shadawanka River, Bauchi State. Assessment of physicochemical characteristics of the river was also attempted to find out the state of the water quality of the river. Four hundred and eighty one species of phytoplankton were recorded. This consisted of 276 species of diatoms, which was made up of 237 species of Pennales and 39 species of Centrales. 123 species of desmids (green algae), 41 species of Euglenophyceae, 34 species of Cyanophyceae, 3 species of Phaeophyceae and Xanthophyceae having 4 species from a single order Heterococcales. Two hundred ad twenty-one algal species in the Epiphytic were identified, 122 species belonged to the Bacillariophyceae. This consisted of 97 species of Pennales and 25 species of Centrales. There were 58 species of Chlorophyceae, 14 species of Cyanophyceae, 7 species of Euglenophyceae, and 3 species of Xanthophyceae respectively. Seventy one species of Epilithic were observed, which included 33 species of Bacillariophyceae consisted of 22 species of Pennales and 11 species of Centrales, 23 species of Chlorophyceae and 9 species of Cyanophyceae and 6 species of Euglenophyceae. The highest species richness (16.50) was obtained in the phytoplankton and the lowest (3.82) was in the Epilithic whilst Epiphytic was an average (10.51). The similarities between phytoplankton and Epiphytic and that between Epiphytic and Epilithic were same (0.17), whilst the similarities obtained between the phytoplankton and Epilithic communities was lower (0.14). The River is well oxygenated (DO>9.8mg/L) and is Characterised by moderate nutrient levels, high electrical conductivity (>204 µmScm^{-1}) and low BOD (2.1-6.4mg/L). pH was circumneutral, having three regimes, this attest that the water is not polluted and can support other forms of aquatic life
Keywords: Centrales, Pennales, Physicochemical, Phytoplankton, Epilithic, Epiphytic

Introduction

The preference for habitat characteristic by certain species of algae has been stressed by Patrick (1988) who claimed that the restriction of certain taxa to a given habitat might probably be as a result of a reflection of the peculiarity of different habitats. The Englenales were found to be restricted to confluences and downstream areas, possibly because of nutrient levels coupled with favourable temperatures, while desmids occupy a wide range of ecological niches (Moss, 1973). Studies have confirmed that, a change in species diversity and phytoplankton taxonomic composition is attributable to changes in nutrient levels (Watson *et al.,* 2007). Reynolds (1984) reported that, such changes are related to the differences between the taxa in terms of storage, nutrients uptake, growth, and loss. Algae and other aquatic organisms are usually considered opportunistic species as they respond quickly to minor perturbations in the physical conditions of their environment (Nwankwo, 1988).

Materials and Methods

Shadawanka River is situated in the Shadawanka military barracks, 2km, off Jos road, east of Wuntin dada village, south of Shadawanka village. It resulted from two confluence rivers namely: Lafiyari and Zamfara rivers. Shadawanka River serves majorly as a source of water for livestock watering and irrigation purposes for both the dry and wet seasons. Aquatic macrophytes common in the river are; *Nymphia lotus L. Pennesetum sp, Andropogon sp, and heteropogon sp*. The dry season usually ranges between the months of November to March while the Wet season last from April to October.

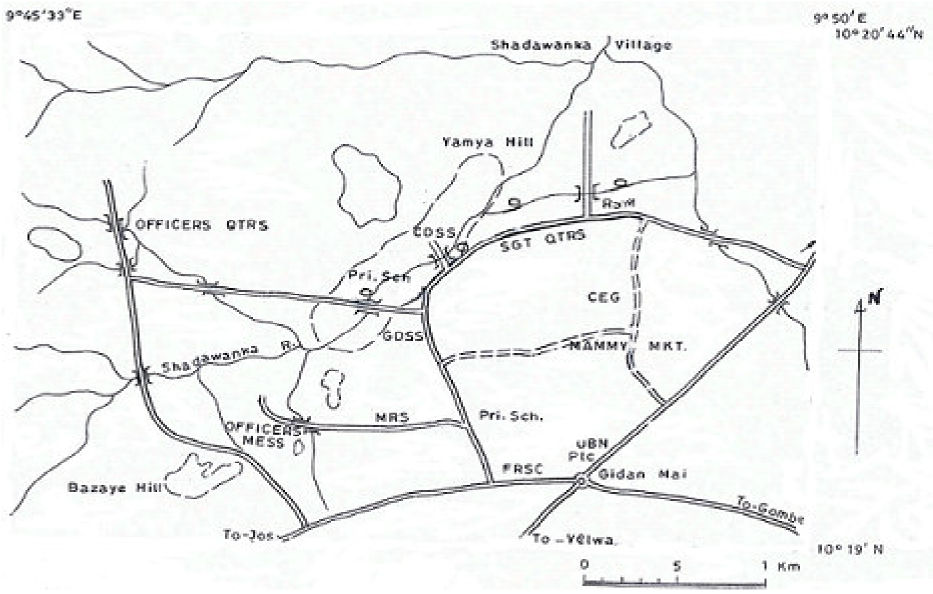

Figure: 1. Map of Shadawanka Military Barracks Showing Shadawanka River

Collection of Samples

Water samples for physicochemical analysis were collected monthly for a period of eight months (February-September 2007) between 7 and 8hours from four stations namely: Stations A, B, C and D (Figure 1) in 1 litre acid rinsed polyethene bottles and transferred to the laboratory in a cooler packed with ice prior to analysis. Samples for biological analysis was obtained as thus: Phytoplankton were collected using a plankton net of mesh size 55µm towed at low speed for 10min and immediately collected in screw capped bottles and immediately fixed with 4% formalin. Epiphytic algae were sampled removing aquatic macrophytes with a sharp razor blade and transferred into polythene bags. Distilled water was then poured into it and agitated vigorously to remove algal materials as suggested by Foester and Schlichting (1965). The algal material was transferred into 250ml bottles. The sample was preserved in 4% unbuffered formalin solution prior to identification. Epilithic algae were sampled following the method suggested by Douglas (1958). In this method, stones surfaces from the bank of the river were measured with a ruler and algal materials scrapped using razor blade. These were collected, transferred into sampling bottles. Distilled water and drops of 4% formalin was added, agitated, and kept for identification.

Analysis of Samples

Physicochemical attributes such as temperature, pH and transparency were measured *in situ* using an ordinary mercury bulb thermometer, a portable Cyber Scan pH meter, model pH^{20} and a 12cm diameter Secchi disc respectively. Electrical conductivity using a combo conductivity meter model, h1-98129, total dissolved solids by evaporation method as described by APHA (1985). Dissolved oxygen titrimetrically Using Wrinkler's method, Nutrients were determined Spectrophotometrically using an Atomic Absorption Spectrophotometer Model VGP 210 and Biochemical Oxygen Demand by Hunts Method.

Results

Biological Indices

a. Species Diversity

This was employed to determine the algal community structure in the river. Antoine et al., (1996) as gave the measure of species richness:

$$R = \frac{S}{\sqrt{n}}$$

Where; S = Number of species
N = Total number of individuals in the sample

b. Coefficient of Similarity between Algal Communities

The coefficient of similarity of the three algal communities namely; Phytoplankton, Epiphyton and Epilithon were determined using the Index of Similarity (S) between each two samples, given as;

$$S = \frac{2C}{A+B} \quad \text{(Odum, 1971)}$$

Where;

A = total number of algae in community A
B = total number of algae in community B
C = number of algae common to Community A and Community B

Species Composition and Relative Abundance of Algal Taxa

A total of 756 algal species (1) were identified belonging to six classes namely; Bacillariophyceae (Diatoms), 431 species (57.0%), which formed the bulk of the algal species; the Chlorophyceae, 218 species (27.0%), Cyanophyceae, 57 species (7.5%), Euglenophyceae, 54 species (7.1%), Xanthophyceae, 7 species (1.0%) and Phaeophyceae, 3 species (0.4%).

Species Richness ("R") of algae in Shadawanka River

The Species Diversity as represented by Species Richness 'R' is presented in Table 1. The highest species richness (16.50) was obtained in the phytoplankton and the lowest (3.82) was in the Epilithon whilst Epiphyton was in between (10.51).

Table 1. Species Richness ('R') of Algal Taxa

Algal Communities	Species Richness ('R')
Phytoplankton	16.50
Epiphytic	10.51
Epilithic	3.82

The Coefficient of Degree of Similarity ("Cz") of algae in Shadawanka River

The Coefficient of Degree of Similarity ("Cz") between the algal communities in the river is presented in Table 2. The similarity between phytoplankton and Epiphytic and that between Epiphytic and Epilithic were same (0.17), whilst the similarity obtained between the phytoplankton and Epilithic communities was lower (0.14).

Table 2. Coefficient of Degree of Similarity between Algal Communities

Algal Communities	Coefficient of Similarity
Phytoplankton Vs Epiphytic	0.17
Phytoplankton Vs Epilithic	0.14
Epiphytic Vs Epilithic	0.17

Table 3 Summary of the Physicochemical Parameters of Shadawanka River

	Station A			Station B			Station C			Station D		
Parameters	**Mean ± S.E**	**Min**	**Max**	**Mean ± S.E**	**Min**	**Max**	**Mean ± S.E**	**Min**	**Max**	**Mean ± S.E**	**Min**	**Max**
Tempt(°C)	24.2±3.59	20.2	28.6	23.7±2.87	20.6	27.2	24.5±2.09	20	27.3	23.6±3.34	20	28.1
Transp(m)	0.22±0.15	0.11	0.33	0.36±0.12	0.22	0.64	0.33±0.06	0.20	0.43	0.40±0.09	0.25	0.55
pH	7.06±0.15	6.8	7.30	6.90±0.45	6.1	7.3	7.11±0.28	6.9	7.7	7.05±0.27	6.5	7.5
No_3-N(mg/L)	6.65±0.52	6.01	7.15	7.13±0.68	6.33	8.0	6.71±0.37	6.24	7.02	6.42±0.38	6.0	6.88
PO_4-P(mg/L)	0.32±0.06	0.22	0.44	0.26±0.06	0.22	0.53	0.20±0.07	0.1	0.28	0.23±0.08	0.1	0.32
DO(Mg/L)	12.73±2.12	10.0	15.8	12.18±1.57	10.2	15.9	11.96±1.35	9.8	13.4	10.97±0.87	9.8	11.9
TDS(mg/L)	0.85±0.24	0.5	1.2	2.86±4.32	0.3	14.3	3.02±4.16	1.0	12.1	3.35±4.23	0.2	11.7
BOD(mg/L)	4.79±0.97	4.8	6.4	4.68±1.17	3.1	6.0	4.38±0.42	3.9	4.2	3.84±0.42	2.1	5.0
EC(µmSc^{-1})	450.6±211.46	210	920	449.6±192.6	230	780	412.6±82.83	204	580	415.2±92.56	245	840

CONCLUSION

Generally, the most marked trend of the wet season over the dry season was; increased Conductivity, Depth, and Phosphate, then decrease in Temperature and Transparency. Other water quality parameters such as Nutrients showed no pronounced temporal trends.

Temperature varied significantly with stations. Station A and D recorded the highest temperature among d stations. Station C recorded the least in the dry season while station A and C had the highest temperature in the dry season which was probably due to changes in depth and time of sampling. Temperatures were virtually same in September but generally lower temperatures fall within the months of July at stations B, C, and D. Station A in August. Lower transparency was observed at station C in June, it varied greatly among all the stations. Transparency was generally low among stations B, C, and D, in the months of April to September. The highest transparency recorded was at station A. There was no definite pattern among the stations, this could be due to time it was determined. pH is invariably same among all the stations. As a general trend, there were no much variations from acidity to alkalinity in station A, and B. A vivid variation was observed in September where acidity was maintained at stations C and D probably due to deposits of waste and domestic inputs like detergents and fertilizers. Nitrate and phosphate varied greatly among all the stations, this could be as a result of increase and decrease in levels of eutrophication. Dissolved Oxygen however, did not vary much among the stations, it had almost same trend of change of change within each station throughout the period of study. Total dissolved Solids had a great variation through both seasons and among stations with the greatest variation at station D in the dry season and station B in the wet season. Electrical Conductivity varied greatly among all the stations, it increased with the wet season. Biochemical Oxygen Demand however did not vary significantly among the stations in both seasons.

Higher numbers of algal biomass were observed towards the end of the year (September) and towards the end of the dry season (March). Bacillariophyceae dominated other algal taxa on several occasions by the pinnate and centric forms. Diatoms dominated both the Epiphyton and Epilithon communities too in the total algal biomass, however, differences were noted during the wet season where less or greater contributions to the biomass of other algal taxa is seen. Antoine (1995), Ezra (1995), and Kadiri (1993) observed this trend on the existence of more than one period of diatom activity.

Chlorophyceae, the green algae came second in abundance to Bacillariophyceae, there was an increase in diatoms and desmids though, fewer numbers were found in the wet season, in varying propositions among the algal communities, these could be as a result of increased flow and high turbidity (low transparency) as reported by Antoine (1995) and Watanabe (1977). The occurrence of higher number of desmids is an attestation of low nutrient status of the river since they are a characteristic of freshwater environment with poor ionic composition as reported by Kadiri (1993 and 1999).

Occurrence of Cyanophyceae was barely inconsistent during the period of study in both seasons, which were common to Phytoplanktonic communities only. It could be possible that, the river is regulated by the flow from station A and its pH values favoured the growth of this group in the river other than on substrate preferences. Cyanophyceae in small number are a natural part of the water system. In large number, they spoil the water system (Thomas, 2000).

Euglenophyceae had almost the same pattern of abundance. Euglenophyceae and Cyanophyceae also had almost the same pattern of abundance with each other and were quantitatively less numerous (7.1% and 7.5% respectively). These two groups are characteristics of Eutrophic or nutrient rich bodies; their poor representation therefore, is rather, a corroboration of poor nutrient status of the river as reported by Kadiri (1996). Phaeophyceae and Xanthophyceae were sparsely represented during the study period.

Most increase in the algal population coincided with periods of longer sunshine hours of increased sunlight intensity and water temperature with low flow and slow current of the river. However, light intensity does not seem to play a major role, since higher intensity reached the riverbed during the dry season due to high transparency. Antoine et al., (1996), also reported this.

Temperature, pH, phosphate and electrical conductivity were highly insignificant when correlated with the total algal cells; this indicates that, they were not limiting factors or playing any major role in limiting the algal growth, however, Transparency, Nitrate, Dissolved Oxygen, Depth and Biochemical Oxygen Demand, Total Dissolved Solids variations showed a significant correlation ($P<0.05$) with algal variables. Physical characteristics and rainfall may be the main contributions factors, which affected the algal growth

Species richness was high probably indicating the contribution of many species in the total algal biomass. According to Nwankwo (1996), low values of diversity index may indicate dominance by one or two species: and high value, when the numbers of species are more evenly distributed (Dispersed) the relatively low Species Richness in Epilithon could be as a result of few rocks sampled. The Coefficient of Degree of Similarity between Phytoplankton and the Epiphytic communities might have resulted from the frequent attachment of algae to the macrophytes and the dislodgement due to wind activities and water turbulence. Similar findings were observed by Ezra (1995) and Nwankwo (1998).

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