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Full Length Research Article

USE OF ALGAE AS A BIOFRIENDLY MEAN TO DETERMINE WATER QUALITY OF ROMI RIVER IN KADUNA, NIGERIA.

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ABSTRACT
Algal samples were collected monthly from five selected sampling stations of Romi River for two years (January, 2015 to December, 2016). A total of 66 species belong to 4 algal classes were recorded during the study period. Palmer, (1969) Algal Genus Pollution Index was employed to study the water quality of Romi River. In 2015, the total score of Algal Genus Pollution Index of station I, II, III, IV and V were 18, 66, 77, 48 and 53 respectively, while in 2016, a total score of the Algal Species Pollution Index were, station I (38), station II (89), station III (76), station IV (61) and station V (51). The total score after the two years for station II - V was greater than 20 indicating a high organic pollution. Considering the entire water parameters study and pollution index, it was clearly shown that the sampling stations II -V were highly polluted than station I. The results of the present study revealed four classes of pollution tolerant species were (*Spirogyra fluviatilis Hilse, Oscillatoria agardhii Gomont* and *Asterionella sp.Spirogyra gratiana Transeau, Euglena gracilis Klebs, Spirogyra sp, Oscillatoria princeps Vaucher* and *Tabellaria fenestrala)*. The polluted surface water quality could be attributed to industrial waste and domestic wastewater at the downstream of the river. Thus, algal communities were confirmed as bioindicator of organic pollution of Romi River.

Keywords: Algae, Bioindicator, Determining, Mean, Pollution, parameter, Quality, Water

INTRODUCTION

Water quality includes inorganic nutrients (particularly phosphate and nitrates), organic pollutants (e.g. pesticides), inorganic pollutants (heavy metals), acidity and salinity. In an ideal situation water quality is to be measure routinely to ensure it safety, but due to constraints of cost and time taken to interpret a result have led to the application of biological monitoring using algae.

Biological monitoring has the advantage of providing a rapid, reliable and relatively in expensive way to record environmental condition across a number of site, it also give a direct measure of the ecological impact of environmental parameters on the aquatic organisms and reflects the overall water quality, integrating the effect of different stress factors (Person, 1989).
Physicochemical measurement provides information on one point in time (Edward and David, 2010).

Natural water maintains a wide variety of aquatic life (example fish, bacteria, algae and protozo of which maintain a dynamic equilibrium with the environment (Manoj and Pooja, 2012). Excessive deposition of chemical nutrients impairs the water quality and as well endangers the aquatic life. Water quality changes are cause by an environmental stress factors such as influx of organic nutrient into a low nutrient water body, there by altering the equilibrium state or dominance of particular bioindicator species of algae community (Dokulil, 2003).
The bases of individual species of algae as bioindicators lies in the preference for (or tolerance of) particular habitat and their ability to grow and out compete other algae under particular condition of water quality

Knowledge of freshwater algae that respond rapidly and predictably to environmental changes has been documented by some Nigerian authors (Akpata, 1993, Nwankwo, 1996, Onyema, 2007, Suzie, 2015).
The aim of this study is to know the use of algae as bioindicator to determine the quality of Romi River, Nigeria.

MATERIALS AND METHODS

Study site

Studied area is located between Longitude: 10 ^{0} 25' 35.3 N and Latitude:7^0 20' 25.06E with elevation 568m above sea level in the northern guinea savannah vegetation zone of Nigeria. Romi River has the largest fresh water body flowing through Rido, Juji, Karatudu and Gonigora. The river is a source of domestic water, building and construction sand. It is suitable for fishing and fadama farming of economically important selected crops such as vegetables and sugar cane.

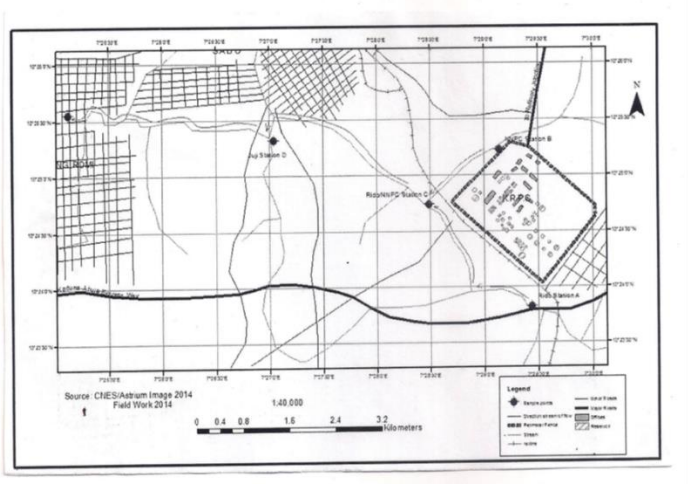

Figure 1: Map of study area showing sampling stations

Sampling stations and water collection

Water samples were collected from five sampling stations upstream Rido and downstream Romi on the basis of drainage pattern and activities in its catchment (Figure 1), Station I (Rido), Station II (NNPC), Station III (NNPC/Rido), Station IV (Juji) and Station V (Romi).

Algal sampling

Water samples for algal analysis were collected monthly between January, 2015- October, 2016 at five selected sampling stations viz, Station I, II, III, IV and V. Palmer (1969) proposed a pollution index based on algal genus and species used in the rating water sample for high or low organic pollution.

Algal Cell Counts

Algal cell count was done using cell counts by drop count method made by (Valencar and Desai, 2004). Each sample was agitated to distribute organisms evenly and one drop was put on to a clean glass slide with a dropping pipette. This was then carefully covered with a cover slip and examined under a microscope with a mechanical stage using a glass slide. The phytoplankton were logically identified and counted in all the microscopic fields. Cells counting start from the left top corner of the slide to the right corner by moving the slide horizontally.

Table 1: Algal Genus Pollution Index (Palmer, 1969)

Algae species	Pollution Index	Algae species	Pollution Index
Anacystis	1	*Micractinium*	1
Ankistrodesmus	2	*Navicula*	3
Chlamydomonas	4	*Nitzschia*	3
Chlorella	3	*Oscillatoria*	5
Closterium	1	*Pandorina*	1
Cyclotella	1	*Phacus*	2
Euglena	5	*Phormidium*	1
Gomphonema	1	*Scenedesmus*	4
Lepocinelis	1	*Stigeoclonium*	2
Melosira	1	*Syndra*	2

Following numerical values for pollution classification of Palmer (1969),
0-10= Lack of organic pollution
10-15= Moderate pollution
15-20= Probable high organic pollution
20 or more = Confirms high organic pollution.

Identification of algae

Identification of algae was carried out using binocular microscope. Some microphotographs were taken using digital camera to further aid identification. Reference on identification of species was made to texts (Patrick and Reinmer, 1966; Needham and Needham, 1962; Prescott, 1961; Chapman and Chapman, 1962; Whitford and Schumacher, 1969). Organisms were identified to generic level.

In this study Palmer, (1969) algal genus pollution index table 1 were employed to study the water quality of Romi River. This water pollution index is used for determination of water pollution.

RESULTS

Table 2: Pollution Tolerant Species of Algae from Stations of Romi River, 2015

		Station				
Algal Taxa	Pollution Index	Rido 1	NNPC 2	NNPC/Rido 3	Juji 4	Romi 5
Class: Bacillariophyceae						
Order: Pennales						
Asterionella sp	1	3	3	3	3	3
Cylindrocystis	2	-	-	2	2	-
Diatoma Vulgaris Bory	1	-	-	-	1	1
Gomphonema contrictum Her	1	-	1	1	-	1
Gomphonema truncatum Her	1	-	-	-	1	1
Gyrosigma kutzing (Her)	4	-	-	4	-	4
Navicula tempunclata Hust	1	-	1	1	-	1
Navicula sp	1	-	-	-	-	1
Nitzschia Invngarise	4	-	-	-	4	-
Synedra Ulna var.	3	3	-	3	3	3
Order: Centrales						
Melosira distans (Her)	1	-	-	-	-	1
Class: Chlorophyceae						
Order: Chlorococcales						
Pediastrum boryanum (Turp)	1	-	1	1	1	1
Order: Ulotrichales						
Ankistrodesmus falcatus (Cords)	3	3	3	3	-	3
Elakatothrix biplex Hinder Var	1	1	1	1	1	1
Order: Volvocales						
Chlamydomonas sp.	3	3	-	-	-	4
Chlamydomonas ngaardii fott	3	-	-	3	3	-
Order: Zynematales						
Closterium lance	1	-	1	1	1	1
Netrium oblongum Var.	2	-	2	2	2	2
Spirogyra fluviatilse	4	-	4	4	4	-
Spirogyra sp	4	-	4	4		-
Class: Cyanophyceae						
Order: Chroococales						
Phormidium tenue f.	1	-	1	1	1	-
Oscillatoria agardhii Gomont	4		4	4	-	-
Oscillatoria rubescens	4	-	4	4	-	-
Oscillatoria brevis kutz	1	-	1	1	1	-
Oscillatoria tenus	4	-	4	4		-
Oscillatoria Limosa (Roth)	4	-	4	4	4	-
Oscillatoria princeps Vaucher	1	-	1	1	1	-
Class: Euglenaphyceae						
Order: Euglenales	5	-	5	5	5	5
Euglena gracilis Klebs	5	-	5	5	5	5
Euglena acus Ehrenbery	5	-	5	5	-	5
Euglena caudata Hubner	5	5	5	5	-	5
Euglena Sengulnea Ehrenbery	5	-	5	5	5	5
Lepocinclis acicularis frnce	1	-	1	-	-	-
Total score		**18**	**66**	**77**	**48**	**53**

The pollution tolerant genus was recorded from the five selected sampling stations following Palmer (1969) identified and prepares a list of 20 algal species tolerant to organic pollution A total of 66 algae species were identified in this study belonging to four classes. In 2015, out of a total 32 species pollution tolerance, 11 species belong to Bacillariophyceae, 9 species Chlorophyceae, 7 species Cyanophyceae and 5 species Euglenophyceae table 2.
Table 3 shows the list of algae species identified pollution tolerance for 2016, 34 species, 16 species belong to Bacillariophyceae, 9 species Chlorophyceae, 5 species Cyanophyceae and 4 species belonging to Euglenophyceae.

In 2015, *Spirogyra fluviatilis Hilse, Oscillatoria agardhii Gomont* and *Asterionella* were identified in the five sampling stations. The highest pollution score (77) was recorded in station 3 (NNPC/Rido) while the Lowest score (18) were recorded in station 1 (Rido). *Spirogyra gratiana Transeau, Euglena gracilis Klebs, Spirogyra sp, Oscillatoria princeps Vaucher* and *Tabellaria fenestrala* were reported in the five sampling stations in 2016. The lowest score value (38) was recorded in station 1 (Rido), while the high score values (89) were obtained in sampling station 2 (NNPC) Figure 1. In term of percentage, in 2015, Euglenophyceae had 37% as the highest percentage follow by Chlorophyceae (25%), Bacillariophyceae had (21%) and Cyanophyceae had 17% (figure 3). In 2016, Bacillariophyceae had the highest 37%, follow by Chlorophyceae with 31%. Euglenophyceae had 22%, Cyanophyceae had 10% (figure 4).

Table 3: Pollution Tolerant Species of Algae from Stations of Romi River, 2016

	Station					
Algal Taxa	Pollution Index	Rido 1	NNPC 2	NNPC/Rido 3	Juji 4	Romi 5
Class: Bacillariophyceae						
Order: Pennales						
Achnanthes minulissima	4	4	4	-	4	4
Amphora ovalis	1	-	1	-	-	-
Asterionella sp.	1	-	1	-	1	1
Cymebella Lanceolata (Her)	1	-	-	-	1	-
Diatoma Vulgaris	2	-	2	2		2
Fragilaria brevistriata Gru	2	2	-	-	2	2
Gomphonema parvulum (kutz)	1	1	1	-	1	1
Gyrosigma spencerii (W.Smith)	4	-	4	4	4	4
Hantzschia vigata (Her)	1	-	1	1	-	-
Navicula sp	3	3	3	-	3	-
Nitzschia seriata	3	3	3	-	3	3
Nitzschia sp	3	3	-	-	3	3
Synedra Ulna Kuzting	2	2	-	2	2	2
Tabellaria fenestrala	3	3	3	3	3	3
Order: Centrales						
Cyclotella comba Kutzing	2	-	-	4	-	4
Melosira Islandica	1	-	1	1	1	-
Class: Chlorophyceae						
Order: Chlorococcales						
Scenedesmus quadricauda	4	-	4	4	4	-
Order: Ulotrichales						
Ulothrix zonata (weterMohr	4	-	4	4	-	-
Order: Zynematales						
Gonatozygon minor (Nageli)	5	-	5	5	5	-
Roya obtusa var	4	-	4	4	-	-
Spirogyra gratiana Transeau	4	-	4	4	4	4
Spirogyra fluviatilis Hilse	4	-	4	4	4	-
Spirogyra sp	4	4	4	4	4	-
Stichococcus bacillaris Nageli	3	3	-	3	-	-
Tetmemorus brebissonii (MENEGH)	4	-	4	4	-	-
Class: Cyanophyceae						
Order: Chroococales						
Chrooccus turgidus Nageli	3	-	-	-	-	3
Merismopedia glauca	4	-	4	-	-	-
Order: Nostocales						
Lyngbya Lachneri	2	-	2	2	2	-
Oscillatoria Limosa	4	-	5	5	5	-
Oscillatoria princeps Vaucher	1	-	1	1	1	-
Class: Euglenaphyceae						
Order: Euglenales						
Euglena gracilis Klebs	5	-	5	5	5	5
Euglena Caudatus Hubner	5	5	5	5	5	5
Phacus proximanygaard	5	-	5	5	-	5
Phacus sp	5	5	5	-	-	-
Total Score		**38**	**89**	**76**	**67**	**51**

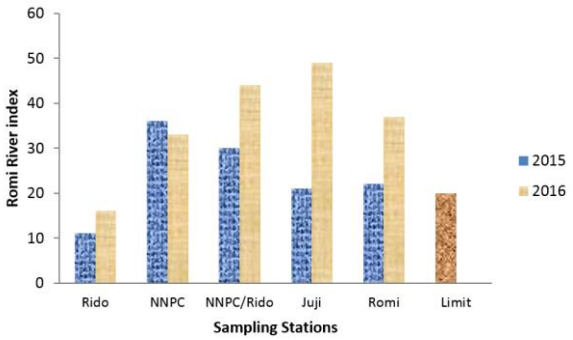

Figure 2: Pollution index score of algal genus at selected sampling stations of Romi River, 2015 -2016

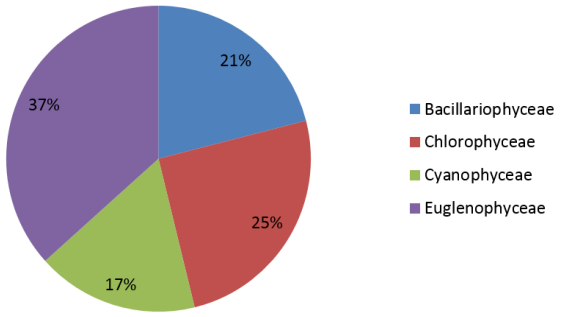

Figure 3: Relative density of different classes of index score of algae, 2015

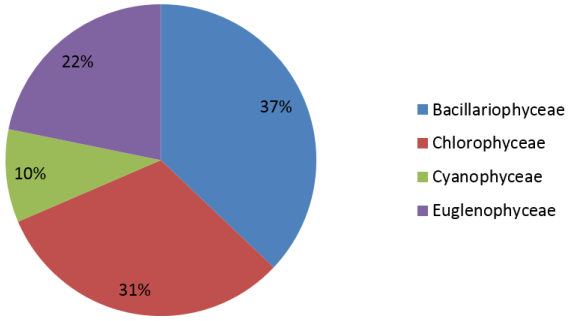

Figure 4: Relative density of different classes of index score of algae, 2016

DISCUSSION

By using Palmer's index of pollution for rating of water samples asorganically polluted at Romi River, five sampling stations were tested. Palmer, (1969) has shown that genus like *Oscillatoria, Euglena, Scenedesmus, Chlamydomus*, *Navicula, Chlorella, Nitzschia* and *Ankistrodesmus* were indicative of organically polluted water. Similar observations were made by Ayodhya, (2013), Jafari and Gunale, (2006), Person, (1989). Similar algae species were recorded in the present study. The occurrence of *Oscillatoria, Euglena, Scenedesmus, Gomphonema* and *Melosira* were recorded repeatedly and considered as indicators of pollution in view of the results of Palmer pollution index. *Asterionella ,Elakatothrix , Spirogyra, Tabellaria* ,Oscillatoria was found to be the most active participant in all stations may be the good indicators of contaminated water bodies' similar observation was made by Akpan and Offem,1993 and Rai *et al*., 2008.

Palmer, (1969), the genus *Oscillatoria* and *Euglena* tops the list of his seventy one most tolerant genera of pollution (Yahuza *et al*., 2011).

The degree of organic pollution was increased at station II, III, IV and V of Romi River and it is confirmed by using Palmer's index. This index suggests eutrophic conditions in Romi River. Algae encountered from the river reflect the eutrophic condition and therefore, may be used as an indicator of water quality. The waters of Romi river, showed number of genera and species like *Oscillatoria, Euglena, Scenedesmus, Gyrosigma, Closterium , Navicula, Nitzschia*, *Gomphonema*, *Spirulina, Synedra* and *Melosira* were recorded repeatedly during the two years of study and could be consider as indicators of pollution in view of the results of Palmer pollution index. Whereas *Oscillatoria, Phormedium, Euglena, Spirogyra, Scenedesmus, Melosira* were dominant can be used as pollution tolerant algae. Patrick, (1965) concluded that *Euglena and Oscillatoria* are highly pollution tolerant genera and therefore, reliable indicators of Eutrophication.

The findings of this study revealed algae sensitive to water pollution in the case of Romi river were the algae from station II, III, IV and V, were polluted effluent water showed the dominance of Scenedesmus quadricauda, Oscillatoria limosa *Euglena gracilis Klebs* and *Phormidium favelarum* throughout the year, which are considered to be indicators of organic pollution. The higher score for Palmer index at station II, III, IV and station V is indicate high organic pollution. While the total scores of station I was less than 20 indicating probable or moderate organic pollution.

Thus, the overall pollution index showed that at station II, III - IV and V, the water showed confirms high organic pollution impair by the effluent waste, while station I off the effluent out pour suggests lack of organic pollution. It was supported by data of physico-chemical analysis of the water during the period of study (Suzie *et al.;,* 2016, WHO,2006). Palmer, (1969) suggested that algae are reliable indicators of water pollution as it was true in the present study.

Conclusion

High pollution was detected at stations II, III, IV and V, 10 top genera pollution-tolerant algae were reports from among the pollution-tolerant genera Euglena, Oscillatoria, Chlamydomonas, Scenedesmus, *Asterionella* , Nitzschia, Navicula, Synedra, *Gyrosigma* and *Lyngbya*, and the top 7 species, Euglena viridis, *Spirogyra fluviatilis*, Oscillatoria limosa, Scenedesmus quadricauda, *Gomphonema constrictum, Gyrosigma Spencerii* and Oscillatoria *agardhii*. In some genera, e.g., Euglena, *Spirogyra,* a single species is far more significant than all others as a pollution-tolerant form. In other genera, e.g., Oscillatoria, only a slight difference distinguishes the pollution tolerance of 2 or more species. Algal genus and species pollution indices arc presented for use in rating water samples with high organic pollution.

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