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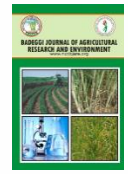

Research Article

Phytoplankton as Bio-indicators of Water Quality in Kazaure Reservoir, Jigawa State, Nigeria

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Abstract
Phytoplankton represents the primary producers in an aquatic ecosystem and one of the important ecological pyramid components of aquatic ecosystem that can serve as pollution indicators. The present study was aimed at assessing Phytoplankton as bio-indicators of water quality in Kazaure reservoir, Jigawa State, Nigeria. Systematic sampling technique was employed to assess the condition of the water. Microscopic observations and identification keys allowed to index phytoplankton taxa. Algal genus and species were used in rating water samples for high or low organic pollution using Palmer Pollution Index (PPI). Means ± standard deviation, ANOVA, were performed using SPSS 20.0.The findings of the study revealed that the water condition supports the water community, comprising of thirty (30) phytoplankton species, representing four (4) major taxa in order of; Chlorophyta>Bacillariophyta>Cyanophyta> Euglenophyta . However the study identified a total of 11 pollution tolerant genera following Palmer organic pollution list including: *Cyclotella* sp., *Gomphonema* sp., *Nitzchia* sp., *Synedra* sp., *Navicula* sp., *Scenedesmus* sp., *Ankistrodesmus* sp., *Oscillatoria* sp., *Euglena* sp., *Lepocincilis* sp. and *Phacus* sp. The species collectively accounted for pollution index value of 29, indicating enriched water with high organic pollution, associated with warning signs of eutrophication in fresh water aquatic system. The study therefore recommends the need for sensitisation by relevant authorities to water users on the impact of contamination from detergents and others on the phytoplankton species and the overall condition of the water.

Keywords: *Kazaure Reservoir, Phytoplankton, Pollution indicator and Water quality*

Introduction
Phytoplankton come under the group of plants called algae and have been recognized as bio-indicator organisms in the aquatic environment (Anyanwu *et al.*, 2021). They are a group of microscopic plants which are minute and spend their whole life in water (Parveen and Arjun, 2012). Phytoplankton organisms have a very important role in the feeding of animals that sustain their life in freshwater, and they form the basis of primary production in aquatic environments. Also, they are one of the biological indicator organisms which are used extensively in many water pollution investigations all over the world (Dochin *et al.*, 2017). Algae are involved in water pollution in several ways; the process of enrichment with excess nutrients, primarily Phosphate-phosphorus and Nitrate-nitrogen, leads to enhanced growth of algae which results in eutrophication (Ngodhe *et al.*, 2013) and Zakariyya *et al*. (2014). Likens (2010) reported eutrophication due to poor water quality as the most challenging global threat to the quality of various water bodies as a result of excess nutrients getting their way through runoff during rainy seasons. It is worth to mention that eutrophication

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and cyanobacterial blooms have long been a source of water quality problems. Dominant presence of colonial blue-green algae like Microcystis and Anabaena genera, form dense summer blooms due to high nutrient concentrations (Anderson *et al.,* 2002); (Zargar and Ghosh, 2006).

Population increase in Kazaure town over the years has translated into increased demand for food production, and other domestic and commercial activities. These activities have resulted in the accumulation of waste that could bring about environmental changes which may lead to water contamination. After nearly four (4) decades of the reservoir's existence with continuous changes, it is important to investigate the water conditions that affect the water in general and quality in particular. The changes may have serious impacts on sustainable uses of the water by the population, and that depends on the condition of the water to support other aquatic communities. Since Phytoplankton serve as primary producers and the basis of the food chain in an aquatic environment, it is feared that such changes could impact them negatively. There are limited researches on the Reservoir; the few available documented works in the past decade include the works of Aminu (2013); the study of assessment of Heavy Metals Bioaccumulation by Tissues of *Ipomoea batatas* and *Manihot esculenta* irrigated with Water from Kazaure Reservoir by Abdullah *et al.* (2015); The Physico-Chemical and Phytoplankton analyses of Kazaure Reservoir were also studied by Abubakar *et al.,* (2015); Oladeji (2020) also studied Physio-chemical properties of the same Reservoir with suggestions for regular monitoring. Of all this work, besides phytoplankton classes listed by Abubakar *et al.,* (2015); no study was carried out to establish the role of phytoplankton as indicators of water quality. However, it is to achieve such study, that the present work is aimed at assessing phytoplankton as bio indicators of water quality in Kazaure Reservoir, Jigawa state, Nigeria

Materials and Methods

Kazaure Reservoir formerly called Muhammad Ayuba Reservoir is a freshwater body constructed between 1974 and 1975. The reservoir is located on 12°39¹10¹¹N and 8°24¹ 43¹¹S. The Dam is an artificial reservoir situated between old and new Kazaure town (Cikin gari and kanti), the two parts are linked by a modern bridge constructed in 2008. The main source of water of the Reservoir is river Katsina, it also receives rain water as well as waste water from the town. The size of the reservoir is 15.65m high earthen-concrete, with a total volume of 299,500 m^3. The area of water is 116 ha, maximum base width 96.32 m and length 1,012 m (WRECA, 1980; Galadima *et al.,* 2021).

The reservoir was constructed to serve as a multipurpose system, with the primary aim of flood control, water consumption, irrigation and fishing, while the secondary benefit is recreation activities. Due to the growing demand for water and limitation from exploitation, total water demand will increase continuously along with urbanization progress. Thus, the reservoir's water storage capacity of 44 years (1974- 2018) is insufficient to serve the increasing population of Kazaure town and environs.

The four sampling sites were designated as Sites A, B, C and D. The four sampling sites are:

Site A **–** This site is the water inlet of the reservoir, where water from Katsina Dam enters the reservoir. The water is within a narrow pathway. There are limited agricultural activities around this site.

Site B **–** This site is the water outlet of the reservoir. It is characterised by various anthropogenic activities including washing of cars, bathing, laundry and animals' activities.

Site C **–** This site is the middle of the reservoirs with dense volume of water. It is characterised by agricultural and fishing activities with pungent and rotten fish smell due to fishing and allied activities at the location.

Site D**-** This site is where water is drawn using irrigation pumps for drinking and other domestic activities with lesser human interference.

Samples for the analyses were collected from Kazaure Reservoir monthly in triplicates from each sampling site for a period of 12 months between the hours of 8:00 am – 10:00 am and transported in light proof cooler containing ice packs as follows:

Phytoplankton samples were collected following the procedure described by APHA (2005); using silk plankton net of 25cm diameter and 70 microns/cm attached with a collection bottle of 50ml capacity at the base. The net was lowered to the depth of 1m at each site. The net was drawn out of the water at a rowing speed. The samples were collected into bottle tied at the end of the net and then emptied into the sample bottles. Samples were immediately preserved in Lugol's iodine solution.

Phytoplankton Sorting and Identification**:** Phytoplankton samples from each site were taken to the laboratory for sorting and identification following the standard procedures of APHA (2005). Slides were prepared and one drop between slide and slip cover were observed three times under light microscope with various magnifications. The identification was carried out using taxonomic keys by; Palmer (1969); Verlencar (2004); Emi and Andy (2007); Edward and David (2010).The phytoplankton were observed and counted from left top corner of the slide to the right corner by moving the slide horizontally. Slides of each sample were prepared in triplicates. Phytoplankton were scored for absence (-) and presence (+) in the different sampling sites. The number of particular species in the mount was also noted. Photographs of the specimens' representative were made by camera with magnification of ×100 and ×400 under the microscope (Mahar, 2003). Further clarification of identified species name was done using Google lens camera.

Statistical analyses were carried out using the Statistical Package for Social Science (SPSS 20) software. All experiments were performed in triplicates and the numerical values were expressed using descriptive statistics as mean± standard deviation. One way ANOVA was used to compare their means and separated by Least Standard Deviation (LSD). Means were considered significantly different at $P<0.05$**.** Tables and Figures were designed using Microsoft excel.

Palmer Pollution Index (P.P.I) was used in rating algal genus and species for high or low organic pollution (Palmer, 1969). Phytoplankton species were assigned pollution index values from 1 to 6. Following analysis, the values were totalled and a score of 20 or more was regarded as confirmation of high organic pollution in the water body while scores of 0 to 9 indicated no organic pollution.

Results and Discussion

Table 1 revealed the Phytoplankton species composition and abundance in the Reservoir**.** The composition of thirty (30) phytoplankton genera distributed into 4 classes was tabulated, with Bacillariophyta accounting for a greater abundance and Euglenophyta having the least abundant species. The total of 1137 organisms/litre were recorded and following Palmer (1969) organic pollution, 11 pollution tolerant genera comprising of *Cyclotella* sp., *Gomphonema* sp., *Nitzchia* sp., *Synedra* sp., *Navicula* sp., *Scenedesmus* sp., *Ankistrodesmus* sp., *Oscillatoria* sp., *Euglena* sp., *Lepocincilis* sp. and *Phacus* sp were identified. The collective Pollution Index (PI) value of 29 was calculated. The current study contributed to the knowledge of the taxonomic composition and abundance of phytoplankton species in Kazaure Reservoir. According to Palmer (1969), a pollution index greater than or equal to 20 indicates high organic pollution. Therefore, the pollution index value of 29 of Kazaure Reservoir indicates enriched water with high organic pollution. Similar findings were reported by Yusuf (2020).

The composition of *Navicula* sp. (Plate 1) (Bacillariophyta), *Cosmarium* sp., (Plate 3), *Sphaerocystis* sp. (Plate 4) (Chlorophyta), *Gomphonema* sp., (Plate 5) *Nostoc* sp., (Plate 8) *Oscillatoria* sp. (plate 2) (Cyanophyta*)*, *Euglena* sp. And *Phacus* sp. (Plates 6 &7) (Euglenophyta) in all the sampled sites of Kazaure Reservoir indicated enriched water with organic pollution. The presence of these species is attributed to their ability to adapt to a wide range of environmental changes from anthropogenic influences. This trend is observed to be common in many African fresh water bodies especially in Nigerian Reservoirs as documented in the work of Atobatele (2013). Uneven distribution of phytoplankton was observed across studied sites.

The study revealed the abundance of Microcystis, Oscillatoria, Nostoc and Anabaena in Site C. This is as a result of high inflow of nutrients into the reservoirs from various pollutants generating activities characterising the Site. This finding is of great concern because the presence of these species poses potential health risks to the inhabitants. Hameed (2019) also reported these notable bioindicator phytoplankton species in Nigerian fresh water body. Ayoade and Aderogba (2020) cautioned that these species are capable of producing cyanotoxins which can cause serious illness in humans and animals in general. Observation of these species revealed the need for continuous biomonitoring and control of organic pollution in the reservoir. In relation to this finding, Indabawa (2010) forecasted and emphasized on the need for regular monitoring of water bodies to protect public health.

The population distribution presented in percentages indicated the occurrence of Phytoplankton taxa in order of Chlorophyta>Bacillariophyta>Cyanophyta>Euglenophyta (Figure 1). This contradicts the findings of Abubakar and Ademoh (2017) who reported different trend in the same Reservoir with Bacillariophyta accounting for greater population. Variation in the two studies is attributed to response of parameters to environmental changes and pollution status of the Reservoir along the length of time. High population of Chlorophyta indicates gradual deterioration of the water quality as explained by Ghosh *et al*., (2012). The trend of Phytoplankton population distibution in this study corroborates with that of many fresh water bodies studied in Nigeria by Abubakar and Abubakar (2013), Ahmad and Indabawa (2015) and Suleiman and Ibrahim (2019). Ewebiyi (2015) attributed this trend to the fact that sensitive species disappear as the water becomes polluted while tolerant ones survive pollution stress.

The total phytoplankton distribution revealed seasonal variation influenced by irrigation and other domestic activities close to the sampled sites. The abundance of Chlorophyta in March, Bacillariophyta and Euglenophyta in May, Cyanophyta in July as shown in Figure 2, revealed variation. The finding is attributed to the impact of Temperature as an important seasonal parameter that controls the biological processes of phytoplankton communities. Heydari (2018) highlighted the impact of temperature in seasonal variation.

Remarkable seasonal trend was observed for abundance of cyanobacteria genera, occurring in the warmer months of the year. These months are characterised by relatively high water temperature. According to several studies, abundance of cyanobacteria genera is favoured by water temperature (Paerl and Paul, 2012). Thus, the odour problems experienced in Kazaure Reservoir during sampling particularly in dry season are partly attributed to the occurrence of *Anabaena* sp.and *Microcystis* sp., which are associated with odour problems and are capable of producing cyanotoxins. Chinyama *et al.* (2016) made similar observation and associated odour problems in fresh water bodies to cynotoxin production in Vaal dam. Al-Hassany (2012) attributed high values during dry season to the reduction in the rate of water flow of a reservoir which allows the sparse plankton already present to multiply before it is swept away. It is worthy to note that the significant variation in the number of Chlorophyta species recorded during rainy season, than dry season is an indication that more species could survive changes in nutrients and increase in water volume which varies with season.

Conclusion

This condition of the water encourages the growth and distribution of phytoplankton taxa. There were thirty (30) phytoplankton species representing four (4) major taxa; Chlorophyta, Bacillariophyta, Cyanophyta and Euglenophyta. Although, eutrophication was not observed in the reservoir, however, Palmer Pollution Index revealed the presence of *Anabaena* sp. and *Microcystis* sp. among other species, which is associated with warning signs of eutrophication in fresh water aquatic system. Therefore pollution indices may deteriorate further. The water in Kazaure reservoir is also threatened by high organic pollution based on the recorded pollution index value of 29. The presence of *Anabaena* sp. (2.64%) and *Microcystis* sp. (2.20%) were not reassuring signs of good water conditions and is linked to odour problems related to gaseous release from metabolic activities**.** The study suggests the need to control cleaning and washing using detergents directly into the Reservoir. In addition, farmers should be sensitized on careful selection of fertilizer to reduce high organic pollution of the Reservoir.

References

Abubakar, M.K., Muhammad, M.A., Anas.A. and Ibrahim, S. (2015). Phytoplankton Survey and Physico-Chemical Assessment of Kazaure Dam, Nigeria. Proceedings of The IRES 3rd International Conference, Dubai, UAE, 34-37.

Abubakar, M. K., and Ademoh, O. A. (2017) Comparative Plankton Survey and Physico-Chemical Assessment of Two Ponds in Kano Metropolis, Nigeria. *Eurasian Journal of Analytical Chemistry*, 13 (3): 193-206.

Abubakar, M. M., and Abubakar, J. Y. (2013). Seasonal dynamics of the phytoplankton in relation to environmental variables in Nguru Lake, North eastern Nigeria. *Journal of Biodiversity and Environmental Sciences (JBES):* 3(1): 88-94.

Abdullah, S.A., Lawan, J., Fowotade, S. A. and Abdu, H. (2015).Assessment of Heavy Metal Bioaccumulation by Tissues of I*pomoea Batatas* and *Manihot Esculenta* Irrigated with water from Muhammad Ayuba Reservoir, Kazaure. *Proceedings of 18th International Conference on Plant and Environmental Sciences*, **2***(2).*

Ahmad, H. K.,and Indabawa, I. I. (2015). A study of Algal species of Kano River, Tamburawa, Kano State, Nigeria. *Bayero Journal of Pure and Applied Sciences*, *8*(1): 42-49.

Al Hassany, J. S., Zahraw, Z., Murtadeh, A., Ali, H. and Sulaiman, N. (2012). Study of the effect of Himreen dam on the phytoplankton diversity in Dyala River, Iraq. *Journal of Environmental Protection*, *3*:940-948.

American Public Health Association (APHA, 2005). Standard methods for the examination of water and wastewater. *American Public Health Association (APHA): Washington, DC, USA*, *21*.

Aminu, M.M. (2013). Physico-chemical and plankton analysis of Kazaure Dam, Jigawa State, Nigeria. M. Sc. Dissertation, Department of Biological Sciences, BUK. Pp. 55-59.

Anderson, D. M., Glibert, P. M., and Burkholder, J. M. (2002). Harmful algal blooms and eutrophication: nutrient sources, composition, and conseq. *Estuaries*, 25(4): 704-726.

Anyanwu, E. D., Adetunji, O. G., and Umeham, S. N. (2021). Assessment of Physicochemical Parameters and Phytoplankton of Eme River, Umuahia, Southeast Nigeria. *Sriwijaya Journal of Environment*, 6(2): 1-12.

Atobatele, O.E. (2013). Pelagic Phytoplankton Succession Pattern in a Tropical Freshwater Reservoir (Aiba Reservoir, Iwo, Osun state, Nigeria). *Bioremediation, Biodiversity and Bioavailability*, 7(1): 81-84.

Ayoade, A., and Aderogba, A. (2020). Spatial and temporal distribution of plankton in a tropical reservoir, southwestern Nigeria. *Egyptian Journal of Aquatic Biology and Fisheries*, *24*(5):161-181.

Chinyama, A., Snyman, J., Ochieng, G. M., and Nhapi, I. (2016). Occurrence of cyanobacteria genera in the Vaal Dam: implications for potable water production. *Water SA*, *42*(3): 415-420.

Dochin, K.; Ivanova, A.; Iliev, I. (2017). The phytoplankton of Koprinka Reservoir (Central Bulgaria): Species composition. *J. BioSci. Biotechnology*, 6: 73–82.

Edward, G. B. and David, C. S. (2010). *Freshwater Algae: Identification and Use as Bioindicators*, Wiley-Blackwell John Wiley and Sons, Ltd, The Atrium, Southern Gate, Chichester, West Sussex, P019 8SQ, UK. Retrieved from www.wiley.com/wiley-

Emi, Y. and Andy, G. (2007). *Phytoplankton Identification Guide*. University of Georgia Marine Education Centre and Aquarium. Retrieved from http://www.marex.uga.edu/aquarium

Ewebiyi, F. O., Appah, J., and Ajibade, G. A. (2015). Taxonomy, distribution and diversity of phytoplankton in some water bodies in Kaduna metropolis

Nigeria. *Journal of Natural Sciences Research*, *5*(15): 85-93.

Ghosh, S., Barinova, S., and Keshri, J. P. (2012). Diversity and seasonal variation of phytoplankton community in the Santragachi Lake, West Bengal, India. *Q Science Connect*, (1) 3.

Hameed, I. O., Adeniyi, I. F., Adesakin, T. A., and Aduwo, A. I. (2019). Phytoplankton diversity and abundance in relation to physico-chemical parameters of Ifewara Reservoir, Southwestern Nigeria. *World News of Natural Sciences*, *24*.

Heydari, N., Fatemi, S. M. R., Mashinchian, A., Nadushan, R. M., and Raeisi, B. (2018). Seasonal species diversity and abundance of phytoplankton from the southwestern Caspian Sea. *International Aquatic Research*, *10* (4): 375-390.

Indabawa, I. I. (2010). Studies on Limnological parameters and Phytoplankton Dynamic of Nguru Lake Yobe state Nigeria. *Bioscience Resources Communication*, *21*(4): 57-80.

Likens, G.E. (2010): Lake ecosystem ecology. Academic Press. San Diego, California.480Pp.

Mahar, M.A. (2003). Ecology and Taxonomy of Plankton of Manchhar lake (Distt. Dadu): Sindh, Pakistan.Unpublished PhD. Thesis University of Sindh, Pakistan. Retrieved from: http://usindh.edu.pk.mukhatiar.ahmadlDessertation_mukhatiar.

Mohammed G., Bashir M. and Garba, A. (2017). Analysis of Physico-Chemical Parameters of Mohammed Ayuba Dam, Kazaure, Jigawa State, Nigeria. *Dutse Journal of Agriculture and Food Security (DUJAFS)*, 4 (1):135-146.

Ngodhe, S.O., Raburu, P.O. and Achieng, A. (2013). The impact of water quality on species diversity and richness of macroinvertebrates in small water bodies in Lake Victoria Basin, Kenya. *Journal of Ecology and the Natural Environment*, 6(1): 32-41

Oladeji, S.O. (2020). Evaluation of physicochemical parameters in wastewater from Muhammad Ayuba dam in Kazaure, Jigawa state, Nigeria. *Archives of Agriculture and Environmental Science*, **5** (4): 482-488.

Paerl, H. W. and Paul, V. J. (2012). Climate change: links to global expansion of harmful cyanobacteria. *Water research*, *46*(5): 1349-1363.

Palmer, C.M. (1969). Composite rating of algae tolerating organic pollution. Journal of Phycology 5(1):78-82.

Parveen R,S and Arjun, B (2012). Plankton biodiversity of siddheshwar Dam in Shingoli, maharashtra, India. *Journal of Environmental Research and Development*, 7 (2): 905-916.

Suleiman, U. F., and Ibrahim, S. (2019). Spatial and temporal patterns of phytoplankton composition in Zobe Reservoir, Dutsinma, Katsina State, Nigeria. *Bayero Journal of Pure and Applied Sciences*, *12*(1): 51-56.

Verlencar, X.N. (2004). Phytoplankton Identification Manual, National Institute of Oceanography Dona Paula, Goa India.

Yusuf, Z. H. (2020). Phytoplankton as bioindicators of water quality in Nasarawa reservoir, Katsina State Nigeria. *Acta Limnologica Brasiliensia*, 32.

Zakariyya, A.M., Adelanwa, M.A. and Tanimu,Y.(2014). Physico-Chemical Characteristics and Phytoplankton Abundance of the Lower Niger River, Kogi State, Nigeria. *Journal of Environmental Science, Toxicology and Food Technology*, *2(4):31-37*

Zargar, S., Krishnamurthi, K., Devi, S. S., Ghosh, T. K. and Chakrabarti, T. (2006). Temperature-induced stress on growth and expression of Hsp in freshwater alga Scenedesmus quadricauda. *Biomedical and Environmental Sciences*, *19*(6): 414.

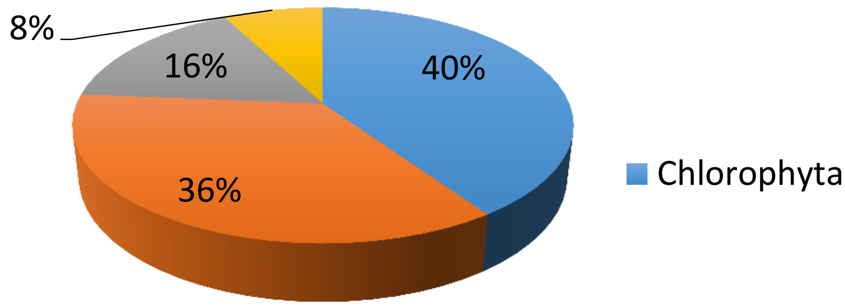

Figure 1 illustrates the population distribution of the four (4) phytoplankton taxa observed.

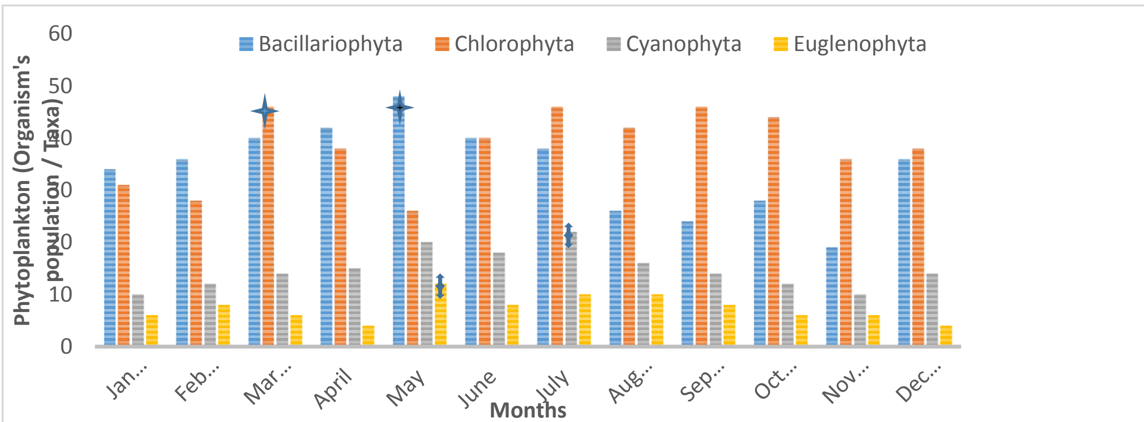

Figure 2. Mean Distribution of Phytoplankton Species across the Months at the Reservoir.

Plate 1. *Navicula* sp.
x 400
Identified in water samples from Sites A, B, C and D of Kazaure Reservouir Jigawa State, Nigeria

Plate 2. *Oscillatoria putrid*
x 400
Identified in water samples from Sites A, B, C and D of Kazaure Reservouir Jigawa State, Nigeria
(January- December, 2018)

Plate 3: *Cosmarium* sp.
X 400
Identified in water samples from Sites A, B, C and D
of Kazaure Reservouir Jigawa State, Nigeria

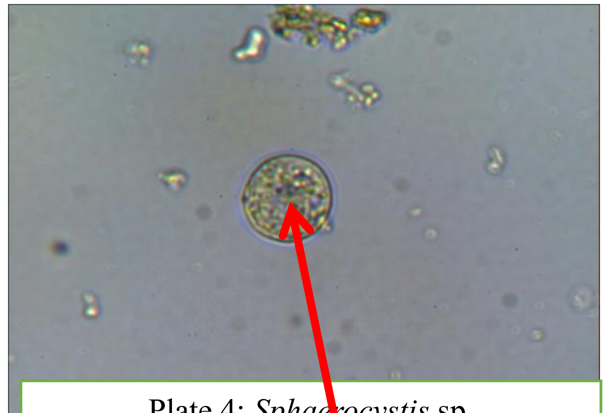

Plate 4: *Sphaerocystis* sp.
x 400
Identified in water samples from Sites A, B. C and D

Plate 5: *Gomphonema* sp.
x 400
Identified in water samples from Sites A, B, C and D of Kazaure Reservouir Jigawa State, Nigeria

Plate 6: *Euglena* viridis
x 400
Identified in water samples from Sites A, B, C and D
of Kazaure Reservouir Jigawa State, Nigeria

Plate 7: *Phacus* sp.
x 400
Identified in water samples from Sites A, B, C and D of Kazaure Reservouir Jigawa State, Nigeria

Plate 8 *Nostoc* sp.
x 400
Identified in water samples from Sites A, B, C and D of Kazaure Reservouir Jigawa State, Nigeria

Table 1. Phytoplankton Species Composition and Abundance in Kazaure Reservoir, Jigawa State, Nigeria

		SITES					
Taxa	**PI Value**	**A**	**B**	**C**	**D**	**Total Org/l**	**Abund (%)**
Bacillariophyta (36.15%)							
Cyclotella sp.	1		21			21	1.85
Cymbella cistula			10			10	0.88
Gyrosigma sp.			22	38	10	70	6.16
Gomphonema gracile.		12		20		32	2.81
Gomphonema sp.	1		26	32		58	5.10
*Meridion*sp.			6			6	0.53
Nitzschia sp.	3	13				13	1.14
Synedra sp.	2	18	11	26		55	4.84
Synedra ulna		12	20			32	2.81
Navicula sp.	3	10	22	46	36	114	10.03
Chlorophyta (40.55%)							
Scenedesmus quadricauda	4	18				18	1.58
Coelastrium sp.		22	8	5		35	3.08
Ulothrix zoonata		12				12	1.06
Cosmarium sp.		18	12	30	10	70	6.16
Pediastrum sp.		14	25		10	49	4.31
Planktosphaeria sp.		15	32		13	60	5.28
Spirogyra sp.		48	12	52	24	136	11.96
Sphaerocystis sp.		6	10	10	5	31	2.73
Palmella sp.		8		12		20	1.76
Ankistrodesmus sp.	2	8		16	6	30	2.64
Cyanophyta (15.57%)							
Microcystis aeruginosa		10	12	8		30	2.64
Nostoc sp.		10	19	10	8	47	4.13
Gomphosphaeria sp.		12	5	10	12	39	3.43
Anabaena sp.			17	8		25	2.20
Oscillataria putrid	5	10	14	8	4	36	3.17
Euglenophyta (7.74%)							0.00
Euglena viridis	5	2	10	5	3	20	1.76
Euglena ascus					7	7	0.62
Euglena gracilis		6			8	14	1.23
Lepocincilis acus	1		4			4	0.35
Phacus sp.	2	10	18	5	10	43	3.78
Total (org/l)	**29**	**294**	**336**	**341**	**166**	**1137**	**100.00**

Key: Red colour (pollution tolerant genera with index values) Abund (Abundance) **Source:** Field work, 2018
Black Colour (genera with no index value)