FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 6 No. 2, April, 2022, pp 18 - 23
DOI: https://doi.org/10.33003/fjs-2022-0602-924

PHYSICOCHEMICAL PROPERTIES AND PERIPHYTIC ALGAE OF IKOT EBAK RIVER, ESSIEN UDIM LGA, AKWA IBOM STATE

***Denise, E. M., Ekhator Osagie, Affah, G. P., Anyadike, M. C.**

Department of Botany and Ecological Studies, University of Uyo. P.M.B 1017 Uyo, AkwaIbom State
Ambrose Ali University, Ekpoma Edo State

*Corresponding authors' email: mukoroemmanuel01@gmail.com

ABSTRACT

Periphyton constitutes one of the primary sources of energy in the aquatic food chain in streams, rivers and lakes. They play important role in regulating carbon and nutrient cycling. They are also used in many studies as pollution index organisms. A survey of Periphytic algae in Ikot Ebak River was investigated between October 2019 and February 2020. Samples were collected monthly for physicochemical analysis and periphyton studies. Water samples for physical and chemical parameters were collected directly into transparent plastic containers, while periphyton samples were scraped from the surface of leaves, stems, and roots of aquatic macrophytes, dead and felled logs submerged on the banks of rivers, including the rocks embedded in the substratum. The physicochemical parameters such as pH, temperature, conductivity, total suspended solids (TSS), total dissolved solids (TDS) and dissolved oxygen (DO) showed seasonal patterns and qualitative variations in all the stations. A total of 106 taxa of periphytic algae were identified and grouped into four (4) divisions namely; Chlorophyta (64%), Bacillariophyta (19%), Cyanophyta (8%) and Euglenophyta (9%). There was no significant variation between the algal divisions and across the locations ($p < 0.05$). The Periphytic green algae compositions were dominated by desmids which play a significanct role in pollution monitoring along the coast of the river. The presence of diatoms (Bacillariophyta) and *Euglena* serves as an indicator that the river is perturbed with organic materials, also *Oscillatoria* (Cyanobacteria) denotes nutrient enrichment of the river.

Keywords: Periphyton, Physicochemical, Nutrient cycling, Pollution, Macrophytes

INTRODUCTION

Algae are the primary source of energy in many aquatic environments. They are widespread and necessary components of an aquatic environment. Microalgae can create energy for aquatic ecosystems in a wide range of physical and chemical circumstances, from hot thermal spring-fed streams to cold, arctic streams (Stevenson et al., 2010). Through photosynthesis, algae fix carbon from the atmosphere, which is then transmitted through the food web and consumer pathway. They are represented by a large number of species and growth forms (Armitage and Fong, 2004). Microalgae can be feasibly measured irrespective of their microscopic nature. They are regarded as a relevant ecological tool in freshwater analysis. Their distribution has a great deal of impact on the health of any water body. Among the many naturally occurring species of algae, there is a wide range of sensitivity or tolerance. The physical appearance of algae makes them attractive for investigating biological responses across a range of stressors and stressor variability. While they fluctuate naturally, as do other aquatic animals, such natural variability can be quantified and integrated into the analysis (USEPA, 2000 and Wehr and Sheath, 2003).

Physicochemical parameters are the physical and chemical parameters that affect the aquatic environment as well as the algal composition and productivity. They are temperature, pH, conductivity, dissolved oxygen, total dissolved solids and others. Temperature is a physical component that affects the properties of water and is recognized as a key factor in the alteration of an aquatic ecosystem's productivity and functioning (Bhateria and Jain, 2016). One of the most essential criteria of water quality is the pH of a body of water. The negative logarithm of the hydrogen ion concentration is what it's called (Spellman, 2017). One of the most significant characteristics of water quality in streams, rivers, and lakes is dissolved oxygen (DO). It's a crucial indicator of water pollution. The higher the dissolved oxygen concentration, the better the water quality. Oxygen is a gas that is only marginally soluble in water and is extremely temperature-sensitive.

In the aquatic ecosystem, periphyton consists of most of the primary producers in lentic water bodies and oceans in the littoral zone, whereas they are fewer in running or lotic water bodies. In the littoral zone, periphyton is a colony of autotrophic and heterotrophic microorganisms connected to a substrate such as sand, rocks, or macrophytes (Marc, 2020). They are a collection of microscopic freshwater photoautotrophic aquatic algae and prokaryotes clinging to the underwater surface (Scott, 2010). Periphyton is a large group of attached algae. They vary in size from the microscopic form to the large macro form of many species (Stevenson, 2014). They are cosmopolitan and are well distributed in almost all aquatic environments. The physical and chemical factors of the environment have a major role in determining the distributions of diverse forms (Stevenson et al., 2010). Algae have a long history of use and many of the characteristics that ecological indicators look for. They were one of the first assemblages produced for use in biological evaluation in the United States and were part of the early saprobien indicator system development in Germany (Stevenson, 2014; Stevenson et al., 2010). Measures of productivity, biomass, and assemblage composition have all been created using algae as indicators. Algae's biological significance and distinct characteristics, notably as indicators of nutrient contamination, make them ideal assessment endpoints for the creation of quantitative nutrient criteria for water quality management under the Clean Water Act (USEPA, 2014). This rating is based on their vulnerability to nutrient contamination as well as their connection to aquatic life, drinking water sources, and designated recreational uses (USEPA, 2000). Few works of literature exist on Ikot Ebak River but no work currently has been reported on the Periphytic algae composition of Ikot Ebak River. The aim and objective of this work are to determine the floristic periphytic compositions and their correlation with the water quality of the River.

MATERIALS AND METHODS

Study Area

Ikot Ebak settlement is located in Essien Udim LGA AkwaIbom state Nigeria. IkotEbak River occupies an elevation of about 88 m above sea level with a depth of about 10 m. It lies between longitude 7°39’0” and latitude 5°7’0’’.

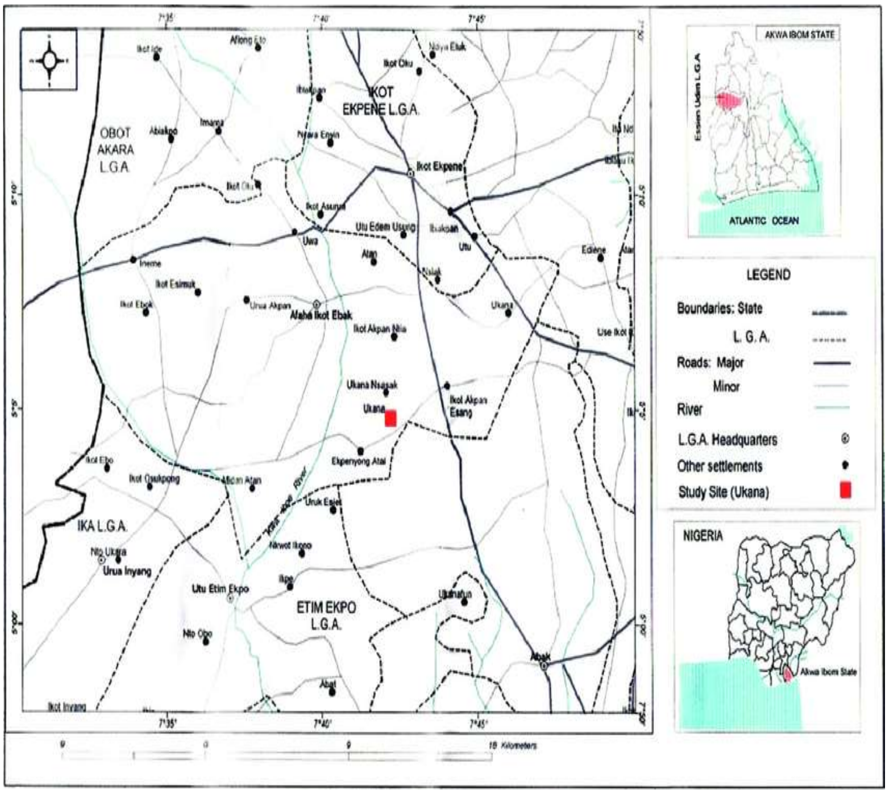

Figure 1. Map of Essien Udim Local Government Area. Uploaded by Nsiken Benson

Sample Collection: Samples were collected from three locations using methods described in APHA, (2005). The water samples were collected monthly for physicochemical analysis and periphyton studies. Periphyton samples were collected by scraping the surface of aquatic macrophyte leaves, stems, and roots, dead and felled logs submerged on river banks, including the rocks embedded in the substratum, while water samples for physical and chemical parameters were collected directly into one litre (1000 ml) transparent plastic containers. All the sampling containers were washed properly with the water sample before collection. All samples were properly labeled and transported to the laboratory. A preservative (Lugol’s iodine solution) was added to the periphytic algal sample while the physicochemical samples were refrigerated (0°C - 4°C) before analysis.

Physicochemical Parameters: The physicochemical parameters of the water samples were analyzed following the procedures of the America Public Health Association (APHA, 2005). The parameters such as water temperature and pH of the river will be measured at the time of sample collection, whereas other parameters will be measured within six hours after collection of the sample.

Temperature: The water temperature was determined using a mercury thermometer. The thermometer will be dipped into the water sample collected with a transparent container and completely immersed in water for 5 minutes and the thermometer reading was recorded as the water temperature when the temperature is steady

pH: The pH of the water samples was determined with the Hanna model pocket pH meter (pHep pocket-sized pH Meter) (Spellman, 2017).

Conductivity and Total Dissolved Solids (TDS): The conductivity and the amount of the total dissolved solids (TDS) of the water samples from the river were measured with conductivity and TDS meter and recorded in µS/cm and mg/L respectively.

Total Suspended Solids (TSS): The total suspended solids (TSS) were determined gravimetrically by adopting the procedure of APHA, (2005). Fifty milliliters (50ml) of the water sample was filtered using a Whatman filter paper (110 mm diameter) which was weighed and designated as W1. The residue in the filter paper was oven-dried and dry to constant mass (till the difference in the successful weighing is less than 0.5 mg) which was weighed and designated as W_2. The difference in weight of the filter paper before and after the evapouration ($W_2 – W_1$) would give the mass of the residue (M). The amount of the suspended solids was expressed in mg/l and calculated using the formula

TDS (mg/L) = $\frac{1000M}{V}$

The mass (M) in mg of the residue was the resultant weight in the difference in weight of the filter paper before and after the evapouration ($W_2 – W_1$). The volume (V) in ml was the volume of the sample (50 ml).

Dissolved oxygen: The dissolved oxygen concentration of the samples was determined by Azide Modification of the Winkler’s method as described by Ramachandra and Solanki (2007).

Statistical analysis: The means and percentage of the data collected were calculated and analyzed using SPSS Version 20. The two-way analysis of variance was used to test the significant difference at the $P < 0.05$ probability level.

RESULTS

The physicochemical properties of river Ikot Ebak observed in the study locations during the investigation period are represented in Figures 2-7.

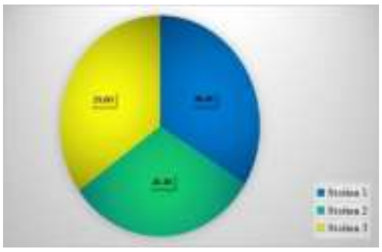
Figure 2: Temperature value of the study areas

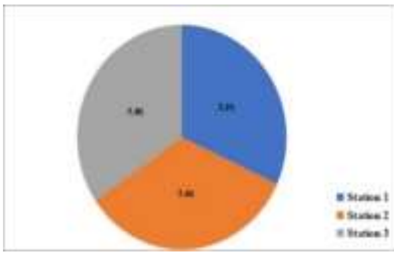
Figure 3:pH value of the study locations

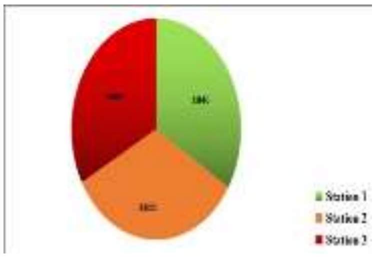
Figure 4: Conductivity value of the study sites

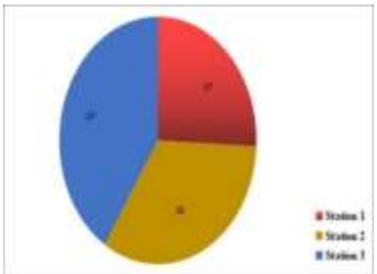
Figure 5: DO value of the study areas

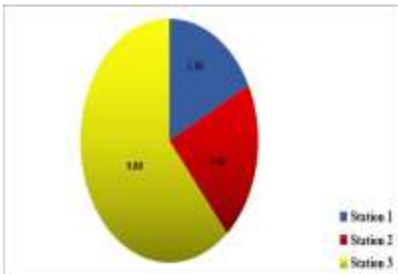
Figure 6: TSS value of the study locations

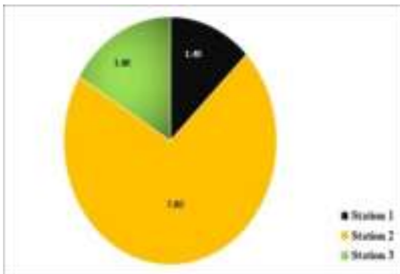
Figure 7: TDSvalue of the study locations

Figure 2 shows temperature variation between the study areas. The value obtained varies between 26°C to 29°C with stations 3 and 1 having the highest and least temperature value respectively. The pH values ranged between 7.21 and 7.81 with the highest value recorded in station 3 as shown in fig. 3. Conductivity values of the station are shown in figure 3. The values ranged from 1800 µS/cm to 1846 µS/cm respectively. Stations 1 and 3 have the highest and least values respectively. The dissolved oxygen content of the river is shown in fig5. The value ranged between 17mg/L at station 1 and 27 mg/L at station 3. Figure 6 shows the total suspended solid of the study area. The values obtained ranged between 2.80 to 9.80 mg/L. The highest value was obtained at station 3 and the least values at station 1. Figure 7 shows the total dissolved solid of the river. The highest value of 7.80mg/l was obtained at station 2 while the least value of 1.40 was obtained at station 1.

The percentage composition of the algal division across the stations during the investigation period was represented in fig 8. The highest composition was observed in the group Chlorophyta followed by the Bacillariophyta, Euglenophyta and Cyanobacteria in ascending order. The Monthly variation of the periphytic algal composition across the different locations during the investigation period from October 2019 to February 2020 was shown in fig. 9. There was no significant spatial variation between the periphytic flora in the algal divisions and across the locations ($p < 0.05$).

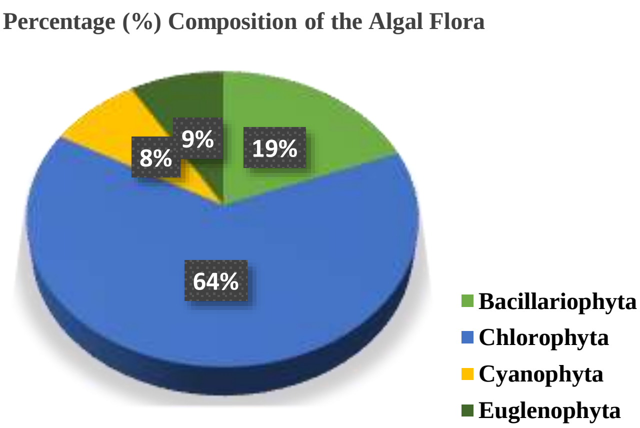

Figure 8: Percentage Composition of the Periphytic Algal Flora in Ikot Ebak River

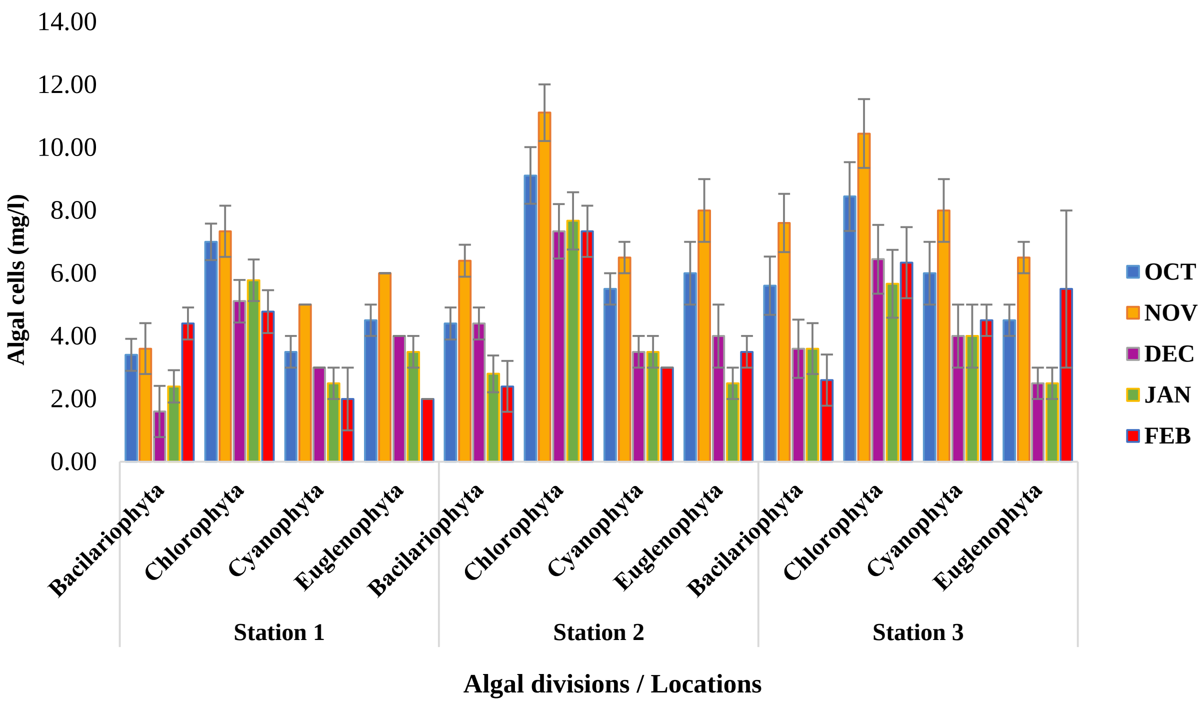

Figure 9: Monthly variation of the periphytic algal composition across the different locations during the investigation

The Periphytic algal composition observed included *Closterium rostratum, Closterium lanceolatum, Spirotaenia condensata, Pleurotanium subcoronulatum, Euastrum didelta, Hyalotheca undulata, Cylindiocystis brebissonii, Chlorella, Oedogonium, Cosmarium* etc. (Chlororphyta). *Navicula, Pinnularia, Synedra, Cyclotella*etc (Bacillariophyta). *Nostoc*, *Oscillatoria* (Cyanophyta), and *Euglena, Phacus* (Euglenophyta).

DISCUSSION

Periphytons are a large group of attached algae. They vary in size from the microscopic form to the large macro form of many species (Stevenson, 2014; Stevenson and Smol, 2003). They are cosmopolitan and are well distributed in most aquatic environments. The distributions of various forms are primarily determined by the prevailing physical and chemical conditions of the environment (Stevenson *et al.*, 2010). The rate of biological activities in freshwater has been reported on different occasions to be influenced by temperature. It plays different roles in the biosphere and it is used in the most aquatic systems as a predictive factor to determine and measure the effects of human activities in the ecosystem (Ogbeibu *et al*, 2012). The mean temperature obtain in this study ranged between 26°C to 29 °C The highest water temperature was recorded at station 3. There was a significant difference in the values of temperature recorded across the stations at ($p<0.05$) fig 1. Eady and Rivers-Moore, 2013 opine that temperature affects the toxicity of other metallic substances. However, the value obtained across all stations in this current study falls within the WHO recommended values.

In this study, the pH value obtained in all stations (Fig 3) ranged from 7.21 to 7.81 and fall within the WHO recommended value of 6.5 - 8 for portable water (WHO, 2011). The lowest pH value was obtained at station one while the highest was recorded at station three. The pH values recorded across the stations in this study showed a significant difference in all three study stations ($p < 0.05$). Generally, all values recorded are slightly between neutral and alkaline. These findings are similar to those reported by (Aremu *et al*, 2011; Edimeh *et al*, 2011 and Adegbola *et al.*, 2021). Fluctuation in pH value in the aquatic ecosystem could be caused by different factors ranging from photosynthesis, respiration, air temperature, disposal of industrial waste and the geology of the underline substratum. The Decomposition of organic detritus can also affect the pH of an aquatic ecosystem (Akoma, 2008).

Electrical conductivity is a reflection of the status of inorganic pollution and a measure of total dissolved salts and ionized fractions in water (Akomeah *et al* 2010 and Shabalala *et al*, 2013). The value obtained (fig 4) varies from 1800-1846 µS/cm in the three stations with a general trend of higher conductivity in station 3. The variation in conductivity could have been inferred by various factors in the study stations. The lower electrical conductivity recorded at station 1 might be due to water dilution, while the highest value recorded in station 3 may be attributed to reduced water volume and high rate of evaporation, sewage disposal and urban and agricultural surface runoff (Adeniyi and Akinwole, 2017). These findings corroborate those of Ovie and Adeniji (1993), as well as, Kolo and Oladimeji (2004) for Shiroro Lake. The variations in conductivities observed at the three sampling stations suggest a considerable amount of dissolved ionic substances entering the river from different sources. Similarly, Adegbola *et al.* 2021 reported that dissolved substances affect the electrical conductivity of a waterbody. The conductivity obtained in this study is at great variance with that recommended by WHO (229 to 600) for drinking water. A significant difference was observed in all the study stations ($p<0.05$).

The natural self-purification of freshwater bodies has been reported by several authors to be enhanced by the dissolved oxygen content (DO) (George *et al*, 2012, *Naubi et al*, 2016 and Olele and Ekelemu 2021). In this study, the dissolved oxygen content ranged between 17.00-27.00 Mg/L.The high value observed in DO content with the highest values in station 3 exceeded the minimal acceptable limit of >5mg/L which has been reported for biota survival for most freshwater bodies. The amount of DO in water is regulated by temperature, nature of sediment and substratum, the amount taken out of the system by decomposing organisms and the amount returned to the system by photosynthetic component. (Elmore et al, 2015). The result implies that the river under investigation is clean and possibly free from organic pollutants and debris. It could also imply increased aeration brought about by increased rainfall, Lower domestic, agricultural, and waste discharged into the River. The Relative higher values recorded at station 3 might be due to the effect of temperature at the time of sampling (fig.1). Dissolved oxygen showed an inverse relationship with water temperature and is an important environmental parameter for rating the survival of aquatic life (EPA, 2001; Iqbal, 2004). The value of dissolved oxygen obtained in this study is in line with numerous scientific studies that suggested 4-5 mg/L of DO as the minimum amount that will support a large diverse fish population. It also falls within the range recommended for good fishing waters (DWAF, 1996).

The value of total suspended solids (TSS)in this study as seen in (fig 5) ranged between 2.80-9.80Mg/L for the three stations. Station one had the least suspended solids while station three has the highest values. Higher values in these attributes may be due to the influx of materials into the river through surface run-off. The increased amount of TSS in Ikot Ebak River could probably be due to the large amount of silt and debris held in suspension just before the rains. The decrease in the level of TSS was probably due to sedimentation when the water current velocity and water level are reduced and could also be due to excavation of sand or sand mining on the watershed of the river which is a common practice by the local settler on the bank of the river in the study area. Heavy road construction activities in the various catchment areas could also have contributed to higher suspended solids.

The total dissolved solids (TDS) test provides a quantitative measure of the amount of dissolved ions present at any point in a water body. It is used as an indicator test for pollution and general determination of water quality (DeZuane, 1977). Amadi *et al*, 2006 in a previous study opine that a low value of TDS reveals a good quality of river water, whereas a high value reveals poor quality hence water with high TDS are likely unhealthy for domestic and portability while those with lower value are safer. In our present study, TDS values ranging from 1.40 ppm to 7.80 ppm are statistically significant across the sampling stations ($p<0.05$)(fig 6). The highest value was obtained at station 2 and the lowest in station 1 (fig.6).The value obtained fall far below the WHO recommended value of 500 ppm of TDS for portable water. This result reveals that the river waters are suitable for domestic and agricultural purposes. This finding is corroborated by the report of other researchers elsewhere (Otobo (1995, Sikoki*et al* 2004).

A total of 106periphytic algae taxa comprising Bacillariophyta, Chlorophyta, Cyanophyta and Euglenophyta division were recorded. Species observed were more with Chlorophyta taxa across the stations. The lowest value was recorded for the Cyanophyta. Chlorophyta has the highest percentage composition contributing 64 % while Cyanophyta, Bacillariophyta and Euglenophyta contributed 36% cumulatively, The Periphyton species were dominated by Nine (9) species of algae in the division Chlorophyta, two in the order Zygnematales and seven in the order Desmidiales. The most dominant of all is the genus *Closterium*. The distribution pattern observed in this could be due to several factors such as substrate composition, level and nature of disturbance ranging from the influence of fishing gear and wind action. It could also be influenced by nutrient composition and the amount of solar radiation prevailing in the various stations. These findings are similar to those of Dunck*et al.*,(2013) who reported the distribution of periphytic algae in Wetlands (Palm swamp, Cerrado) Brazil.

CONCLUSION

The present study shows the relevance of the physicochemical attribute concerningthe distribution and floristic nature of the periphytic algal composition of the river. The higher values of richness are mainly due to adequate prevailing physicochemical parameters and lower organic impact of the river. We observed the importance of moderate and conducive pH levels mainly responsible for the pattern of the floristic composition of periphytic species. The periphytic algal composition by the percentage of the study includes a total of 106 taxa of periphytic algae made up of four (4) divisions namely; Chlorophyta (64%), Bacillariophyta (19%), Cyanophyta (8%) and Euglenophyta (9%). The Periphytic green algae compositions were dominated by desmids which play a significant role in pollution monitoring along the coast of the river.

REFERENCES

Adegbola G. A., Soyewo, L. T., Odey, B. O. and Ajani A. B (2021). River water quality assessment and Its suitability for irrigation purpose. *FUDMA Journal of Sciences*, 5(3), 413-419

American Public Health Association (APHA). (2005). *Standard Methods for the Examination of Water and Wastewater*. Washington D.C, U.S.A, 1036 pp

Armitage, A. R. and Fong, P. (2004). Upward cascading effects of nutrients: shifts in a benthic microalgal community and a negative herbivore response. *Oecologia,* 139, 560 – 567.

Bhateria, R. and Jain, D. (2016). Water quality assessment of Lake water: A review. *Sustainable Water Resources Management*, 2, 161-173

Dezuane, J. (1977), *Handbook on drinking water quality* 2nd edition, 45pp.

Department of Water Affairs and Forestry (1996) South African Water Quality Guidelines (second edition). Volume 6: *Agricultural water use: aquaculture*. 185pp.

Dunck, B, Nogueira,I.S and Felisberto (2013). Distribution of Periphytic algae in Wetlands(Palm swamp, Cerrado) Brazil. *Brazilian Journal of biology*, 73, 331-346.

Environmental Protection Agency, (2001) *Parameters of water quality*: Interpretation and standards. E.P.A., Ireland, 133pp.

Iqbal, F., Ali, M., Salam, A., Khan, B.A., Ahmed S., Qamar M., and Kashif U. (2004) "Seasonal variations of Physicochemical characteristics of River Soan water at DhoakPathan Bridge (Chakwal)", *Pakistan. Int. J. Agri. Biol.*, 6(1), 89-92pp.

Kolo, R. J., and Oladimeji, A. A (2004), "Water quality and some nutrient levels in Shiroro Lake
Niger State. Nigeria". *Journals of aquatic sciences*.19(2), 99pp.

Marcs, L. H. (2020). The Roles: Beyond Competition. *Ecology and Management of Inland Waters,* 151-181 pp.

Otobo, A.J.T (1969), The Ecology and Fishery of the Pygmy Herring *Sierratherissaleonensis* (Thys van Dan Audenaerde) (Clupeidae) in the Nun River and Taylor Creek of the Niger Delta, University of Port Harcourt *Ph.D Thesis*, 221pp.

Ovie S. I., and Adeniji R. A. (1993) "Zooplankton and Environmental characteristics of Shiroro Lake at the Extremes of Hydrological Cycle", *Hydrobiologia*, 175-182 pp.

Ramachandra, T. V. and Solanki, M. (2007). *Ecological Assessment of Lentic Water Bodies of Bangalore*. Technical Report. Environmental Information System (ENVIS). India, 98 pp.

Scott T. L. (2010). A prospectus for periphyton: recent and future ecological research. *Journal of North American Benthological Society*, 29(1), 182-206.

Sikoki, F.D., and Veen, J.V. (2004) Aspects of water quality and the potential for fish production of Shiroro reservoir, Nigeria, *Liv. Sys. Sus. Dev*. 2, 7pp

Spellman, F. R. (2017). *The Drinking Water Handbook*. 3rd ed. Boca Raton: CRC Press; 2017

Stevenson, J. (2014). Ecological assessments with algae: a review and synthesis. *Journal of Phycology* 50(3), 437-461.

Stevenson, R., Pan, Y. and Van Dam, H. (2010). Assessing environmental conditions in rivers and streams with diatoms.*The Diatoms: Applications for the Environmental and Earth Sciences,* 2nd ed. Cambridge University Press, Cambridge: 57-85pp

United States Environmental Protection Agency (USEPA). (2000). *Nutrient Criteria Technical Guidance Manual: Rivers and Streams*. EPA-822-B-00-002.Office of Water, Office of Science and Technology. Washington, DC. 21pp.

United States Environmental Protection Agency (USEPA). (2014). *U.S. EPA Expert Workshop: Nutrient Enrichment Indicators in Streams: Proceedings April 16–18, 2013*. EPA-822-R-14-004.Office of Water. Washington, DC. 24pp.

Wehr, J. D. and Sheath, R. G. (2003).*Freshwater Algae of North America: Ecology and Classification*. Academic Press, Boston, MA, 918pp.

Wetzel, R.G. and Likens, G. E. (1991). *Limnological Analyses*, second ed. Springer-Verlag, New York, N.Y. 65pp.

WHO, (1984) *Guide lines for drinking water quality*. World Health Organization, Geneva
211pp.

.