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Phytoplankton Determination of the Trophic Status and Portability of Aiakhuakhuari River, Benin City, Edo State, Nigeria

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Abstract

A limnological study of phytoplankton composition of Aiakhuakhuari river in Oredo local government area was carried out for six months to assess the water quality using phytoplankton composition of the river. Three sampling stations were chosen and phytoplankton samples were collected (using 55 µm plankton net) and values for air temperature, water temperature, pH and total dissolved solids were estimated *in situ*. A total of 135 phytoplankton species were identified comprising 4 divisions namely; bacillariophyta, *Chlorophyta*, euglenophyta and cyanophyta. Bacillariophyta, which was represented by two orders (centrales and pennales), dominated the phytoplankton taxa, of which they accounted for 45.92% of the total phytoplankton composition. The division *Chlorophyta* made the second highest contribution (38.52%), with bulk belonging to the order Zygnematales. The euglenophyta was represented by one order (*Euglenales*) and three genera (*Euglena*, *Trachelomonas* and *Strombomonas*) contributed 8.89%, while cyanophyta made the least contribution (6.67%) and had 4 genera (*Dactylococcus*, *Oscillatoria*, *Phormidium* and *Anabaena*). The high and low relative abundance of bacillariophyta and cyanophyta respectively, indicate that Aiakhuakhuari river is not polluted, oligotrophic and low in productivity. The physic chemical parameters also showed that the river was not polluted when compared with WGO and SON standard for portable water. It recommended that there should be routine check on the portability of all sources of portable water for safety and health sustainability.

Keywords: Phytoplankton • Oligotrophic • Pollution • Bacillarophyta • Cyanophyta • Water quality

Introduction

Phytoplankton study is paramount in water quality study, based on its role in the productivity of a water body. Water body status can be easily accessed based on its phytoplankton composition and distribution. Phytoplankton has been used as water quality indicator. Phytoplankton adapted partly or continuously in open water. It is a major biological tool used in the assessment of the ecological and pollution status of surface waters and the variation provide a good indication of energy turnover in aquatic ecosystem due to its sensitivity to change in environment.

The balance of physical, chemical and biological properties of a river is essential for successful production of aquatic resources. Productivity of any water body is determined by the amount of plankton it contains. Phytoplankton is ecosystem engineers that alter materials availability within a water body. Phytoplankton have long been used as water quality indicators, because of their short life span and ability to respond quickly to environmental changes, hence, species composition indicates the quality of the water in which they are found. Most aquatic systems around the world undergo changes due to anthropogenic disturbances. Amongst the freshwater organisms, phytoplankton, as primary producers forms the vital energy source. They also control the growth, reproductive capacity and population characteristics of aquatic biota. Phytoplankton is important in environmental impact study in as much as they are extremely responsive to change in the environment and thus indicate environmental changes and fluctuations that may occur. Phytoplankton is very useful tool for pollution studies. Algal measurements are often key components of water quality monitoring programs.

The trophic status of a water body is an important aspect of quality monitoring, as it indicates the effect of effluents, sewage and other wastes discharged into it. Water bodies enriched with nutrients shows excessive growth of phytoplankton. Biological assessment is a useful alternative for assessing the water quality since biological communities integrate the environmental effects of water chemistry. Phytoplankton reflects the average ecological condition and is useful indicators of water quality. Phytoplankton constitutes one of the known parameters with which water quality can be assessed and ascertained. This study aimed at using the phytoplankton composition of Aiakhuakhuari river in Oredo local government area

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of Edo state to assess its trophic status and served as a baseline study of the phytoplankton composition of Aiakhuakhuari river [1].

Materials and Methods

Geography of the area

The study was carried out on river Aiakhuakhuari situated in Oredo local government area of Edo state with longitude 6010'32"N-6011'24"N and latitude 5029'52"E-5030'38"E. It takes its source from Ureghine community and drained into Ogba river. It is located in a tropical rain forest and vegetation is composed of trees, shrubs and grasses. There was abundance of *Elaeis* spp. the dominant macrophyte was *Nympaea lotus* and the abundant fern was *Pteridium aquilinum*. The herbs included *Commelina benghalensis*, *Canna indica* and *Costus alfa*. The climatic condition in this region is characterized by two seasons: Rainy season and dry season (Figure 1).

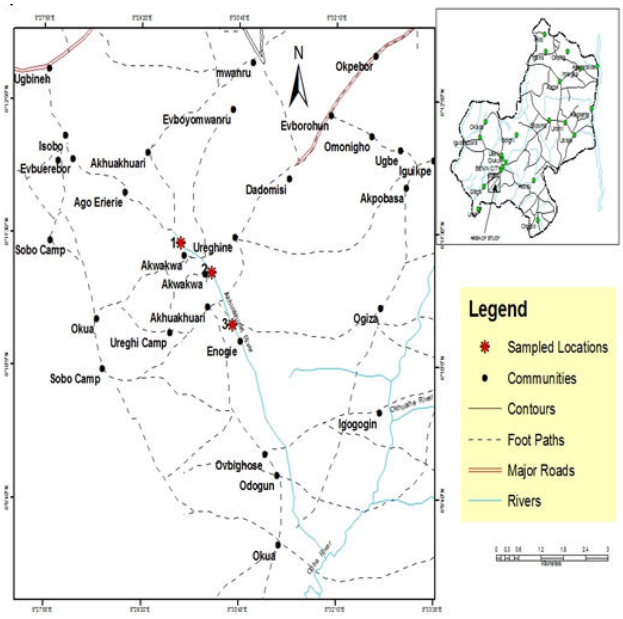

Figure 1. Map of Akhuakhuari and environs showing the sampled locations.

Sampling stations

Samples were collected monthly for six months, from three stations representing the three points of sample collection namely station 1, station 2 and station 3. Station 1 is located upstream with shrubs, grasses and fern present. Human activity such as washing of farm produce like *Manihot esculentus*, takes place here. Station 2 is located near the bridge and it is exposed to direct heat of the sun. It has *Nymphaea lotus* as the dominant macrophyte at time of study. Human activities such as bathing, washing of clothes and washing of automobiles, are done here. Station 3 majorly serves as a source of drinking water for the inhabitants. *Nymphaea lotus* is also the dominant macrophyte here. Plants found in this station are *Commelina benghalensis*, *Ipomoea aquatica*. Meanwhile, laundry and collection of water for portable use are the major human activities here [2].

Sample collection

In each of the sampling stations, phytoplankton samples were collected. 55 µm mesh size phytoplankton net was towed in the open water for about 10 minutes, after which the net dipped in to sampled locations to rinse all phytoplankton samples into the plankton bucket. The net samples were transferred in to labeled plankton bottles and immediately preserved with 4% formalin prior to observation.

Phytoplankton examination

Phytoplankton was examined by wet mount technique with the aid of omax light trinocular microscope. Photographs were taken using a digital camera. Identifications were made with reference to standard texts and journal publications.

Results

Composition of phytoplankton

The phytoplankton flora of the three stations studied in Aiakhuakhuari river consist of one hundred and thirty five taxa which belong to four divisions, nine orders, seventeen families, twenty nine genera. Division bacillariophyta and chlorophyta have 45.92% and 38.52% respective compositions, thereby constituting majority of the entire phytoplankton. These were followed by euglenophyta which contributed 8.89% (12 taxa) and the least were cyanophyta which contributed 6.67% (9 taxa) to the total phytoplankton composition. The bacillariophtya consist of sixty two taxa, majority of which belong to the order zynematales (mainly desmids). The class *Bacillariophyceae* was composed of the centrales and pennales with the pennales having a majority of 83.83%. The chlorophyta consist of fifty two species among which *Spirogyra* spp. and *Closterium* spp. occurred as the most widespread in all the stations [3-5].

The diatoms (bacillariophyta) were evenly distributed with *Pinnularia* spp. *Navicula* spp. as the most abundant taxa in all the three stations throughout the six months of sampling. The green algae (chlorophyta) were also present in all the sampled stations with *Spirogyra* spp. and *Closterium* spp. as the most widespread throughout the six months of sampling and *Dactylococcus infusionum* was seen only in the month of April at station 1. Euglenoids (euglenophyta) were less distributed in station 2 but present at stations 1 and 3 in the month of April. *Cyanobacteria* (Cyanophyta) were scantily distributed in the study, but were dominant in the month of April at station 1 (Tables 1-3 and Figure 2).

Division	Classes	Order	Families	Genera	Total taxa	% Taxa composition of the flora
Chlorophyta	1	5	6	9	52	38.52

Division	Classes	Order	Families	Genera	Total taxa	% Taxa composition of the flora
Chlorophyta	1	5	6	9	52	38.52
Euglenophyta	1	1	1	3	12	8.89
Bacillariophyta	1	2	8	14	62	45.92
Cyanophyta	1	1	2	4	9	6.67
Total	4	9	17	29	135	100

Table 1. Phytoplankton composition of Aiakhuakhuari river (for the period of 6 months).

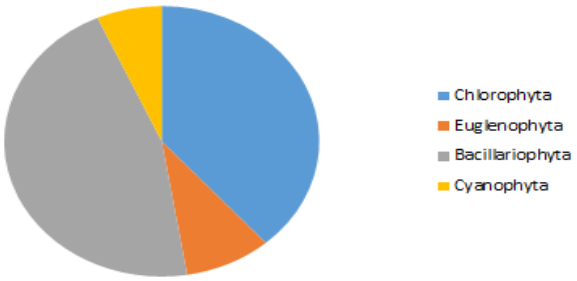

Figure 2. Relative contribution of each algal division to the composition of phytoplankton of river Aiakhuakhuari (for the period of six months).

Parameter	Station 1	Station 2	Station 3
Air temp	29	30	28
Water temp	30	30.1	30.3
TDS	4	4	11
pH	6.1	6	5.9
EC	8	9	20
DO	6.1	6.3	7.1
BOD	3.01	3.1	3.4
TD	3.2	4.8	3.2
Ca	0.64	1.28	0.64
Sulphate	0.25	0.25	0.1
Na	0.74	0.86	0.83
COD	4	4	6
Ammonium-nitrogen (NH_4-N)	0.1	0.1	0.05
Fe	0.03	0.04	0.04
Chloride	3.5	3.5	7.09
Nitrate	0.85	0.85	1.09
Magnesium	0.39	0.39	0
Phosphate	3.01	3.1	3.4
Turbidity	2.8	3.22	4.21
Alkalinity	6.1	6.1	6.1
Potassium	0.51	0.59	0.58
Total hardness	1.6	1.62	3.23

Table 2. Average physio chemical result of river Aiakhuakhuari (for the period of six months).

Parameters	SON (2007)	WHO (2003)	Aikhuakhuari river
Total dissolved solids (mg/L)	500	1500	4-11
Dissolved oxygen (mg/L)	10	10	6.1-7.1
Biochemical oxygen demand (mg/L)	10	10	3.01-3.4
pH	6.5-8.5	6.5-8.5	5.9-6.1
Conductivity (μScm^{-1})	1000	1000	8-20
Total hardness (mg/L)	150	500	1.6-3.23
Nitrate (mg/L)	50	50	0.85-1.09
Phosphate (mg/L)	NA	40	3.01-3.40
Calcium (mg/L)	200	200	0.64-1.28

Note: NA: Not Available; WHO: World Health Organization; SON: Standard Organization of Nigeria

Table 3: Comparison of Akhuakhuari river range of parameters with national and international standards for permissible levels for some measured parameters in drinking water.

Discussion

The results of this study has shown the phytoplankton richness of Aiakhuakhuari river, which varied considerably from some other studies in Nigeria. It is higher than the 41 species in Ogun river reported by Dimowo and it is lesser than the 169 species in Elechi Creek recorded by Davies, et al. Species richness, which is an important part of species diversity and an expressive of the trophic status of an aquatic ecosystem, was indicative in Aiakhuakhuari river. Water bodies with low pollution level have high species diversity. The order of dominance in the phytoplankton composition is bacillariophyta>chlorophyta>euglenophyta>cyanophyta [6-8]. The phytoplankton community was dominated by diatoms (bacillariophyta) close to 50% of the composition. The predominance of phytoplankton community by diatoms (centrales and pennales) in this study conforms to earlier findings in Nigerian water bodies and this is noteworthy because diatoms are known to be indicators of water quality and environmental conditions. The dominance of diatoms is indicative of oligotrophic status, acidic pH and relative cleanness of the water body. The order pennales is dominant over the order centrales in this study and this conforms to previous studies carried out on freshwater bodies. chlorophyta was the second dominant group after bacillariophyta. Similar order of dominance was recorded by Ekwu, et al. Desmids such as Closterium species were evenly distributed in all the sampled locations. They are usually present in oligotrophic water bodies and the abundance of desmids indicates low nutrient levels. The occurrence of the division cyanophyta as relatively fewer species is indicative of their considerable specializations and intolerance of high degree of environmental variability [9-11].

Euglenophyta constitute 8.89% (3 taxa) of Aiakhuakhuari river composition, this shows that they are indicators of organically polluted environment, which accounts for the few euglenoids observed during the study [12]. The physic chemical parameter also showed that the river did not exceed recommended standards for portable water, proposed by WHO and SON. It is now evident that Aiakhuakhuari river is not contaminated above recommended standards and can be used for different household purposes [13]. It recommended that there should be routine check on the portability of all sources of portable water for safety and health sustainability [14,15].

Conclusion

The phytoplankton dominance of bacillariophyta over cyanophyta and euglenophyta in this study indicates that Aiakhuakhuari river is not yet polluted and has low trophic status. Hence, preventive measures should be put in place so as to prevent it from being polluted. This work serves as a baseline study and it is of no doubt that river Aiakhuakhuari has undergone seasonal and successional changes in term of its species richness, species diversity and dominance. Hence, more studies should be carried out for proper documentation of its phytoplankton flora. Also, a long term assessment needs to be done on the river so as to ensure the health and safety of the inhabitants of Aiakhuakhuari community who make use of the river for different purposes including portable use.

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