



EFFECT OF ANTHROPOGENIC ACTIVITIES ON PERIPHYTON ALGAL ASSOCIATION OF NWANIBA RIVER

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ABSTRACT

Freshwater ecosystems are increasingly threatened by anthropogenic activities that alter their physicochemical and biological integrity. This study investigated the impact of human activities on the physicochemical parameters and periphyton community of the Nwaniba River, Akwa Ibom State, Nigeria. Water samples were collected from three stations along the river—upstream (control), midstream (domestic waste influence), and downstream (agricultural and light industrial influence). Standard methods were employed to assess parameters including pH, dissolved oxygen, turbidity, conductivity, temperature, and nutrient levels, while periphyton samples were analyzed for composition, abundance, and diversity. Results showed that Bacillariophyta (47.4%) dominated the algal community, indicating relatively good water quality, while Chlorophyta (31.6%) reflected nutrient enrichment and early eutrophication linked to domestic and agricultural inputs. Charophyta (15.8%) suggested the presence of clean and oxygen-rich sections, whereas low Euglenophyta abundance (5.3%) indicated minimal organic pollution. Overall, findings reveal that while the Nwaniba River retains some ecological balance, increasing anthropogenic pressures are altering its water quality and periphyton structure, posing risks of progressive degradation if unmanaged.

Keywords: Nwaniba River, Anthropogenic Activities, Physicochemical Parameters, Periphyton, Sustainable Management

INTRODUCTION

Freshwater ecosystems are vital to the sustenance of biodiversity and provide critical ecosystem services such as water supply, fisheries, recreation, and nutrient cycling. Among these, rivers play a pivotal role in regulating ecological balance and serving as a source of water for domestic, agricultural, and industrial uses. However, increasing anthropogenic pressures such as urbanization, industrial discharge, agricultural runoff, and domestic waste disposal have significantly altered the physicochemical and biological integrity of many freshwater systems (Allan, 2004; Dudgeon *et al.*, 2006). The Nwaniba River, located in Akwa Ibom State, Nigeria, is no exception. This river serves as a lifeline for the surrounding communities, but its ecological health is increasingly threatened by human activities.

The impact of anthropogenic activities on river systems is typically manifested through changes in physicochemical parameters such as pH, temperature, dissolved oxygen, turbidity, electrical conductivity, total dissolved solids, and nutrient concentrations (e.g., nitrates and phosphates). These parameters influence the habitat quality and availability for aquatic organisms, including periphyton—an assemblage of algae, bacteria, fungi, and detritus attached to submerged surfaces (Wetzel, 2001). Periphyton plays a key role in primary production and nutrient cycling and serves as a bio-indicator of water quality due to its sensitivity to environmental changes (Stevenson, 1996; Rimet and Bouchez, 2012). Similarly, Akpan and Offem (2011) observed elevated levels of nutrients and reduced oxygen concentration in the Calabar River, which they attributed to waste disposal and effluent discharge. In a study conducted on the Ogunpa River in southwestern Nigeria, Akaninwor and Egwim (2006) recorded severe pollution due to urban waste input, resulting in decreased biological diversity.

In relation to periphyton, anthropogenic inputs have been shown to alter community structure and productivity. Excessive nutrient enrichment, especially nitrogen and phosphorus from fertilizers and sewage, often leads to algal blooms or shifts in periphyton composition, favoring tolerant species over sensitive ones (Biggs, 2000). For example, a study by Ogbuagu and Ayoade (2012) on the Imo River revealed that the periphyton community structure was significantly influenced by increased nutrient loads and reduced flow conditions caused by nearby anthropogenic disturbances.

Despite the growing concern, there is limited empirical data on the ecological status of the Nwaniba River, especially regarding the interactive effects of physicochemical changes and periphyton dynamics due to human activities. Given the river's importance to local livelihoods and the growing anthropogenic pressures in the region—including sand mining, agriculture, urban development, and effluent discharge—there is a need for scientific evaluation of these impacts. This study, therefore, seeks to investigate the effect of anthropogenic activities on the physicochemical parameters and periphyton community structure of the Nwaniba River. Understanding the linkages between human activities and aquatic ecosystem health will not only help assess current degradation levels but also support informed conservation and management strategies for the sustainable use of the river system.

MATERIALS AND METHODS

Study Area Description

The study was conducted along the Nwaniba River, located within Uyo Local Government Area, Akwa Ibom State, Nigeria (5.0320°N, 7.9073°E). The river flows through various land-use areas including residential, agricultural, and

peri-urban zones, thus exposing it to multiple anthropogenic stressors such as domestic waste, agricultural runoff, and small-scale industrial effluents.

Sampling Stations

Three distinct stations were selected based on varying degrees of human activities:

- i. Station 1 (Upstream/Control): Characterized by minimal human impact.
- ii. Station 2 (Midstream): Located near residential areas and receives domestic wastewater.
- iii. Station 3 (Downstream): Influenced by agricultural and light industrial activities.

Periphyton Sampling and Analysis

Sampling: Periphyton samples were collected by scrubbing submerged surfaces such as stones and aquatic plants with a soft-bristled brush. The dislodged material was rinsed into labeled sample bottles and preserved in 4% formalin (Wetzel, 2001; APHA, 2017).

Assessment of Anthropogenic Activities Field reconnaissance and structured surveys were conducted to identify sources of anthropogenic inputs (Canter, 1996). Information was gathered through direct observation, photography, and interviews with local residents. Land use patterns were mapped with the aid of GPS and GIS tools where applicable.

RESULTS AND DISCUSSION

Discussion

The study of the Nwaniba River shows that human activities are gradually altering its ecological balance. Bacillariophyta accounted for 47.4% of the total algal abundance, making them the dominant group. Diatoms are widely recognized as indicators of good water quality because they flourish in stable environments with adequate dissolved oxygen and silica availability (Patrick, 1973). Their dominance suggests

that the Wana River still maintains relatively healthy ecological conditions despite potential anthropogenic pressures. Similar observations were reported in the Warri River by Arimoro and Ikomi (2008), where diatom prevalence reflected moderate nutrient enrichment without severe ecological degradation.

Chlorophyta formed 31.6% of the algal population, representing the second most abundant group. Green algae are opportunistic species that respond rapidly to increased nitrogen and phosphorus inputs, often associated with agricultural runoff, domestic sewage, and organic enrichment (Nkwoji et al., 2010; Ezekiel et al., 2011). Their significant presence may therefore indicate early signs of eutrophication within the Wana River. This finding aligns with Odiete (1999), who reported that nutrient enrichment in Nigerian freshwater systems often shifts algal communities toward tolerant taxa such as Chlorophyta.

Charophyta contributed 15.8% of the algal assemblage. Charophytes are typically associated with clean, well-oxygenated, and undisturbed waters, as they are sensitive to turbidity and nutrient enrichment (Stevenson et al., 2001). Their moderate abundance suggests that while portions of the river still support good ecological status, human activities such as agriculture, sand mining, and waste disposal (Ogbeibu et al., 2007; Malmqvist and Rundle, 2002) may be gradually exerting pressure on these sensitive taxa.

Euglenophyta accounted for only 5.3% of the algal population. Euglenoids typically thrive in organically polluted and nutrient-rich waters (Palmer, 1969). Their minimal representation in the Wana River indicates that organic pollution levels are low, corroborating the dominance of diatoms and charophytes. This pattern is encouraging, as rivers receiving high organic loads usually experience shifts toward tolerant taxa, oxygen depletion, and biodiversity loss (Izonfuo and Bariweni, 2001).

Results

S/N	Algae name	Habitat	Habit	Form	Phylum	Class	Order	Family	Genus
1	<i>Diatomeae</i>	Bentic zone	Unicellular	Pennate	Bacillariophyta	Bacillariophyceae	Pennales	Thalassiosiraceae	Thalassiosira
2	<i>Spirogyra</i>	Fresh water	Colonial	Filamentous	Charophyta	Zygnematophyceae	Zygnematales	Zygnemataceae	Spirogyra
3	<i>Bacillariophyceae</i>	Fresh water	Unicellular	Valve structure	Bacillariophyta	Bacillariophyceae	Naviculales	Naviculaceae	Navicula
4	<i>Navicula radiosa</i>	Brackish water	Free living	Elongated	Bacillariophyta	Bacillariophyceae	Naviculales	Naviculaceae	Navicula
5	<i>Pennate diaty</i>	Fresh water	Free living	Unicellular	Bacillariophyta	Bacillariophyceae	Pennales	Bacillariaceae	Nitzschia
6	<i>Flagilaria crotonensis</i>	Fresh water	Planktonic	Filamentous	Bacillariophyta	Bacillariophyceae	Flagilariales	Flagilariaceae	Flagilaria
7	<i>Cyclotella meneghiniana</i>	Fresh water	Planktonic	Unicellular	Bacillariophyta	Coccosinodiscophyceae	Thalassiosira	Cyclotellaceae	Cyclotella
8	<i>Synedra ulna</i>	Fresh water	Planktonic	Filamentous	Bacillariophyta	Bacillariophyceae	Flagilariales	Flagilariaceae	Synedra
9	<i>Chlamydomonas reinhardtii</i>	Fresh water	Planktonic	Unicellular	Chlorophyta	Chlorophyceae	Chlamydomonadales	Chlamydomonadaceae	Chlamydomonas
10	<i>Closterium ehrenbergii</i>	Fresh water	Planktonic	Unicellular	Chlorophyta	Zygnematoceae	Desmidiaceae	Closteriaceae	Closterium
11	<i>Pleurotaenium ovatum</i>	Fresh water	Photosynthetic	Cell shape	Charophyta	Zygnematophyceae	Desmidiaceae	Closteriaceae	Pleurotaenium
12	<i>Closterium moniliferum</i>	Fresh water	Photosynthetic	Elongated	Charophyta	Zygnematophyceae	Zygnematales	Closteriaceae	Closterium
13	<i>Cosmarium contractum</i>	Fresh water	Unicellular	Microscopic	Chlorophyta	Zygnematophyceae	Desmidiaceae	Desmidiaceae	Cosmarium
14	<i>Closterium lineatum</i>	Fresh water	Unicellular	Elongated	Chlorophyta	Zygnematophyceae	Desmidiaceae	Closteriaceae	Closterium
15	<i>Closterium acerosum</i>	Fresh water	Unicellular	Elongated	Chlorophyta	Zygnematophyceae	Desmidiaceae	Closteriaceae	Closterium
16	<i>Asterionella Formosa</i>	Fresh water	Colonial	Elongated	Bacillariophyta	Bacillariophyceae	fragilariaceae	fragilariaceae	Asterionella
17	<i>Euglena</i>	Fresh water	Unicellular	Elongated	Euglenozoa	Euglenophyceae	Euglenales	Euglenaceae	Euglena
18	<i>Pinnularia</i>	Fresh water	Unicellular	Elongated	Bacillariophyta	Bacillariophyceae	Naviculales	Naviculaceae	Pinnularia
19	<i>Pediastrum boryanum</i>	Fresh water	Colonial	Colonial	Chlorophyta	Chlorophyceae	Sphaeropleales	Hydrodictyceae	Pediastrum

Algal Group

Algal Group	Percentage Abundance (%)	Remarks/Ecological Implications
Bacillariophyta	47.4%	Bacillariophyta, or diatoms, are the most dominant algal group in the river. Their dominance suggests good water quality with moderate nutrient levels and stable conditions. Diatoms also indicate a healthy ecosystem with adequate silica availability.
Chlorophyta	31.6%	Chlorophyta shows significant presence, forming the second most abundant group. A relatively high proportion of green algae may indicate increased nutrient availability (especially nitrogen and phosphorus), pointing to mild eutrophication or slight organic enrichment.
Charophyta	15.8%	Charophyta is moderately represented in the algal population. Their presence reflects clean, well-oxygenated, and undisturbed water. Charophytes are often associated with good ecological status and low pollution levels.
Euglenophyta	5.3%	Euglenophyta are the least represented algal group in the river. Euglenoids typically thrive in nutrient-rich or polluted waters. Their low abundance suggests minimal organic pollution and generally healthy environmental Conditions.

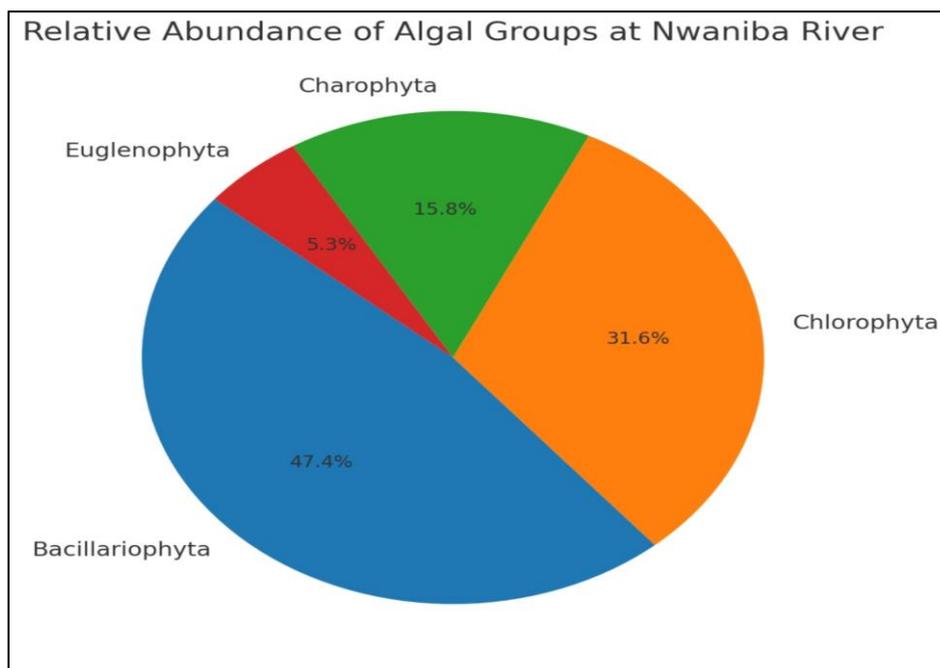


Figure 1: Abundance and Ecological Implications of Nwaniba River

Interpretation of Results

A total of nineteen (19) algal taxa were identified from the sampled stations along the Nwaniba River, representing four major algal groups: Bacillariophyta, Chlorophyta, Charophyta, and Euglenophyta. The identified species comprised both unicellular and colonial forms inhabiting predominantly freshwater environments, with a few species occurring in brackish conditions. Most taxa were planktonic, while some were associated with the benthic zone.

Bacillariophyta (diatoms) constituted the dominant algal group, accounting for 47.4% of the total abundance. Members of this group included genera such as *Navicula*, *Nitzschia*, *Cyclotella*, *Synedra*, *Asterionella*, *Pinnularia*, and *Thalassiosira*. The majority of the diatoms were unicellular and exhibited either pennate or elongated forms. Their dominance indicates that diatoms were widely distributed across the sampling locations.

Chlorophyta represented the second most abundant group, contributing 31.6% of the total algal composition. Species recorded under this group included *Chlamydomonas reinhardtii*, *Cosmarium contractum*, *Closterium lineatum*, *Closterium acerosum*, and *Pediastrum boryanum*. Most of these were unicellular or colonial freshwater forms, predominantly planktonic in habit.

Charophyta accounted for 15.8% of the algal population. Species identified within this group included *Spirogyra*, *Pleurotaenium ovatum*, and *Closterium moniliferum*. These taxa were mainly freshwater and photosynthetic, exhibiting filamentous or elongated cell structures.

Euglenophyta was the least represented group, contributing 5.3% of the total abundance. The only representative recorded was *Euglena*, a unicellular and elongated freshwater species. Overall, the algal community structure showed a predominance of Bacillariophyta, followed by Chlorophyta, Charophyta, and Euglenophyta. The distribution pattern indicates that the river supports a diverse assemblage of primarily freshwater, unicellular, and planktonic algal species.

CONCLUSION

The study of the Nwaniba River revealed that anthropogenic activities particularly agricultural runoff, domestic waste disposal, and light industrial discharge are gradually altering the river's ecological integrity. The dominance of Bacillariophyta indicates that the river still retains relatively good water quality; however, the notable presence of Chlorophyta suggests the early stages of eutrophication. Although the occurrence of Charophyta reflects areas of clean, well-oxygenated water, the overall trend points toward increasing ecological stress due to sustained human interference. If appropriate management strategies are not implemented, the river's capacity to sustain biodiversity and provide essential ecosystem services may be seriously compromised.

To safeguard the ecological health of the river, several measures are recommended. First, continuous monitoring of physicochemical parameters and periphyton composition should be strengthened to detect and manage early signs of environmental degradation. Effective pollution control strategies must be introduced, including the establishment of proper waste management systems within surrounding communities to reduce domestic and agricultural effluents entering the river. Community awareness programs are also essential to educate local residents on the ecological importance of the river and to promote sustainable practices that minimize harmful inputs. In addition, relevant government agencies should enforce environmental regulations to curb indiscriminate waste disposal and uncontrolled agricultural runoff. Finally, restoration initiatives such as the establishment of riparian buffer zones and reforestation along riverbanks should be encouraged to enhance and maintain the long-term ecological stability of the Nwaniba River.

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