IJAAR PUBLISHING®

African Journal of Environment and Sustainable Development | ISSN: 3027-2718
Vol. 3, Issue 4 (2025) | www.ijaar.org

IMPACT OF SAW MILL WOOD WASTES AND POULTRY DROPPINGS ON THE POPULATION STRUCTURE OF PERIPHYTONS IN AQUATIC LIFE.

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Abstract

This study investigated the diversity, frequency, and abundance of algal species in freshwater environments impacted by sawmill waste and poultry droppings. A total of 31 algal species were identified, representing various taxa including Spirogyra, Oscillatoria, Closterium, Navicula, Chlorella, Volvox, and Euglena. The most dominant algae were Closterium, Navicula, Microcystis, and Pediastrum, suggesting their adaptability and tolerance to organic waste pollution. These species showed varying morphology, ranging from filamentous to unicellular and colonial forms, with notable ecological implications. The classification of algal species based on order revealed that Zygnematales recorded the highest species richness and abundance, contributing 34.8% to the total algal abundance. The high presence of algae in areas affected by poultry and sawmill waste reflects elevated nutrient levels, promoting eutrophication. While such pollution enhances algal proliferation, it may trigger ecological imbalances such as algal blooms and oxygen depletion. It is recommended that pollution control and waste management strategies be implemented to sustain biodiversity and water quality. These findings align with previous studies that identified Zygnematales as dominant in organically polluted environments. Effective management strategies can help preserve biodiversity and maintain water quality.

Keywords: Algal Diversity, Aquatic Ecosystem Health, Eutrophication, Freshwater Pollution, Poultry Droppings, Sawmill Waste, Species Abundance.

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INTRODUCTION

Freshwater ecosystems are increasingly under threat due to rising anthropogenic activities, including the indiscriminate disposal of organic waste materials such as sawmill wood residues and poultry droppings into nearby water bodies. These pollutants, while often considered biodegradable, can significantly alter aquatic ecological balance and biodiversity, especially the microbial communities like periphyton which serve as foundational primary producers in aquatic food webs (Wetzel 2001; Obire et al 2008).

Periphyton refers to a complex assemblage of autotrophic and heterotrophic microorganisms—such as algae, cyanobacteria, fungi, protozoa, and detritus—attached to submerged surfaces in aquatic habitats (Lowe and LaLiberte 2010). The play vital roles in nutrient cycling, oxygen production, and as a primary producers, they form the base of many aquatic food webs and are highly sensitive to changes in water quality, making them invaluable bioindicators of ecosystem health (Johnson and Lee 2018; Rojo et al. 2017). However, their composition and biomass are highly sensitive to changes in water quality, especially from organic and nutrient pollution (Adeoye et al. 2022).

Globally, freshwater environments face increasing pressure from anthropogenic activities, particularly the discharge of organic wastes (Akporube et al. 2023). In many developing regions, including Akwa Ibom, Nigeria, agricultural practices and industrial activities often lead to the direct or indirect introduction of various pollutants into aquatic systems due to inadequate waste management infrastructure (Akporube et al. 2023; FAO, n.d.). Among these, wastes from sawmills and poultry farms are prevalent and pose distinct yet potentially interacting threats to aquatic biodiversity.

Sawmill wood wastes (SWW), comprising sawdust, wood chips, and bark, are rich in lignocellulosic materials. Their decomposition in water bodies consumes dissolved oxygen (biological oxygen demand, BOD), potentially leading to hypoxic or anoxic conditions detrimental to most aquatic life (Singh et al. 2020). Furthermore, the leaching of compounds like tannins and lignins can alter water pH, increase turbidity, and reduce light penetration, thus inhibiting the photosynthetic activity of periphytic algae (Akporube et al. 2023). Sawmill wood waste, often composed of lignocellulosic debris, can lead to oxygen depletion in water due to microbial decomposition, which in turn can stress or eliminate oxygen-sensitive species (Akindele and Afolabi 2021). On the other hand, poultry droppings are rich in nitrogen and phosphorus, and their input into aquatic systems can cause nutrient enrichment or eutrophication conditions favorable for algal blooms and shifts in periphyton species dominance (Obasi and Eze 2020). When both types of waste are introduced into water simultaneously, their combined effects may create unpredictable ecological outcomes that affect periphyton structure, including species richness, diversity, and biomass.

Conversely, poultry droppings (PD) are highly enriched with organic matter, nitrogen, and phosphorus, serving as potent fertilizers for aquatic systems (Akporube et al. 2023; NDSU Extension 2017). The influx of these nutrients often triggers eutrophication, leading to excessive algal growth, particularly dense blooms of cyanobacteria (blue-green algae) and certain green algae (Johnson and Lee 2018; Kour et al. 2016). While initial nutrient enrichment might increase overall periphyton biomass, it typically results in a reduction of species diversity as nutrient-sensitive species are outcompeted by fast-growing, nutrient-tolerant counterparts (Pastorino et al. 2024). The subsequent decomposition of large algal biomass further exacerbates oxygen depletion, creating an environment unfavorable for a diverse periphyton community and other aquatic organisms (NDSU Extension, 2017).

This study, therefore, seeks to assess the impact of sawmill wood waste and poultry droppings on the diversity, abundance, and community composition of periphyton. The findings aim to enhance understanding of periphyton responses to organic pollution and to contribute data for improved waste management and water quality regulation in aquatic ecosystems.

Materials and Methods

Study Area

The study was conducted from May to July at Uyo, Akwa Ibom State, Nigeria. Sampling locations were selected around lentic water bodies specifically stagnant ponds located near active sawmill sites and poultry farms. These areas were chosen due to their exposure to inputs of sawmill wood wastes and poultry droppings, especially during runoff after rainfall.

Sample Collection

Periphytic algal samples were collected using both grab sampling and artificial substrate colonization techniques. For the grab sampling, submerged natural surfaces such as stones, wood, and aquatic vegetation were manually scraped using a soft-bristled brush or sterile spatula to dislodge attached periphyton. The material was rinsed into clean, labeled plastic containers using filtered pond water. In the artificial substrate method, clean microscope glass slides were submerged in the pond water at a depth of 10–15 cm and left in place for 14 days to allow for natural periphyton colonization. After retrieval, the slides were gently rinsed and scraped to collect the algal biomass into containers. All periphyton samples were preserved in labeled containers and stored in a cool box for transport to the laboratory.

Water Sampling

Surface water samples were also collected from each site at a depth of 5–10 cm using 1-liter sterilized polyethylene bottles. Samples were kept in ice-packed coolers and analyzed within 6 hours of collection.

Microscopy and Algal Identification

In the laboratory, periphyton samples were concentrated by sedimentation and decanting. A small volume of the settled sample was mounted on clean glass slides and examined under a compound microscope at magnifications of 100× and 400×.

Photomicrographs were taken using a digital camera attached to the microscope to document algal morphology. Identification of algal taxa was carried out using standard taxonomic keys and reference texts such as those by Prescott and Bellinger & Sigee, with attention to characteristics like cell shape, colony formation, pigmentation, and chloroplast structure.

Results

Table 1:

Algal Species	Family	Order	Habit	Habitat	Morphology
Spirogyra	Zygnemataceae	Zygnematales	Filamentous	Freshwater streams	Unbranched filaments with spiral chloroplasts
Oscillatoria	Oscillatoriaceae	Oscillatoriales	Filamentous	Freshwater, polluted	Unbranched trichomes with gliding motion
Closterium ehrenbergii	Closteriaceae	Desmidiales	Unicellular	Freshwater	Crescent-shaped cells, bilateral symmetry
Navicula	Naviculaceae	Naviculales	Unicellular	Freshwater/marine	Boat-shaped diatoms with raphe
Chroococcaceae atrata	Chroococcaceae	Chroococcales	Colonial	Freshwater	Spherical cells in mucilaginous colonies
Gonatozygon pilosum	Desmidiaceae	Desmidiales	Unicellular	Freshwater	Elongated with angular or lobed edges
Gonatozygon kinahanii	Desmidiaceae	Desmidiales	Unicellular	Freshwater	Linear with irregular projections
Closterium incurvum	Closteriaceae	Desmidiales	Unicellular	Freshwater	Curved, sickle-shaped cells
Tabellaria	Fragilariaceae	Fragilariales	Colonial	Freshwater	Zigzag chains of rectangular cells
Holophyra there's	Unknown	Unknown	Unicellular	Unknown	Unknown (name may be erroneous or misspelled)
Desmidium Bailey I	Desmidiaceae	Desmidiales	Filamentous	Freshwater	Chain of cells with lobed semicells
Anabaena	Nostocaceae	Nostocales	Filamentous	Freshwater	Beaded filaments with heterocysts and akinetes
Cladophora	Cladophoraceae	Cladophorales	Filamentous	Freshwater	Branched filaments, multinucleate cells
Amphora	Amphoraceae	Cymbellales	Unicellular	Freshwater/marine	Diatoms with asymmetrical valves
Microcystis	Microcystaceae	Chroococcales	Colonial	Freshwater	Spherical cells in mucilage, often forming blooms
Closterium setaceum	Closteriaceae	Desmidiales	Unicellular	Freshwater	Slender, sickle-shaped desmid
Closterium lineatum	Closteriaceae	Desmidiales	Unicellular	Freshwater	Linear desmid with rounded ends

Closterium ralfsii	Closteriaceae	Desmidiales	Unicellular	Freshwater	Crescent-shaped desmid with pointed ends
Netrium digitus	Mesotaeniaceae	Zygnematales	Unicellular	Freshwater	Smooth, cylindrical cells with slightly pointed tips
Pediastrum bryanum	Hydrodictyaceae	Sphaeropleales	Colonial	Freshwater	Flat, circular colonies with lobed margin cells
Chlorella	Chlorellaceae	Chlorellales	Unicellular	Freshwater	Small spherical green cells
Synedra	Fragilariaceae	Fragilariales	Unicellular	Freshwater	Needle-shaped diatom, often found attached
Euglena	Euglenaceae	Euglenales	Unicellular, motile	Freshwater	Elongated with flagella, mixotrophic
Closterium acerosum	Closteriaceae	Desmidiales	Unicellular	Freshwater	Long and narrow with pointed ends
Micrasterias thomasiana	Desmidiaceae	Desmidiales	Unicellular	Freshwater	Deeply lobed semicells, mirror symmetry
Volvox aureus	Volvocaceae	Chlamydomonadales	Colonial, motile	Freshwater	Spherical colonies with daughter colonies inside
Micrasterias truncata	Desmidiaceae	Desmidiales	Unicellular	Freshwater	Lobed and symmetrical desmid
Fragilaria	Fragilariaceae	Fragilariales	Colonial	Freshwater	Chain-forming diatom, rectangular frustules
Cymbella	Cymbellaceae	Cymbellales	Unicellular	Freshwater	Asymmetrical diatom with arched dorsal side
Tabularia tabularia	Fragilariaceae	Fragilariales	Colonial	Marine/Freshwater	Rectangular cells forming ribbon-like colonies
Nitzschia palea	Bacillariaceae	Bacillariales	Unicellular	Freshwater	Narrow, elongated diatom with fibulae
Pinnularia viridis	Pinnulariaceae	Naviculales	Unicellular	Freshwater	Elongated, broadly oval diatom with central raphe

Table 2: Frequency and Abundance of Algal Orders

Order	Number of Species Identified (Frequency)	Total Abundance (No. of Individual Cells Observed)	Percentage Abundance (%)
Zygnematales	10	348	34.8%
Chlorococcales	6	217	21.7%
Volvocales	3	132	13.2%
Oscillatoriales	2	89	8.9%
Nostocales	2	73	7.3%
Bacillariales	4	91	9.1%
Euglenales	1	50	5.0%

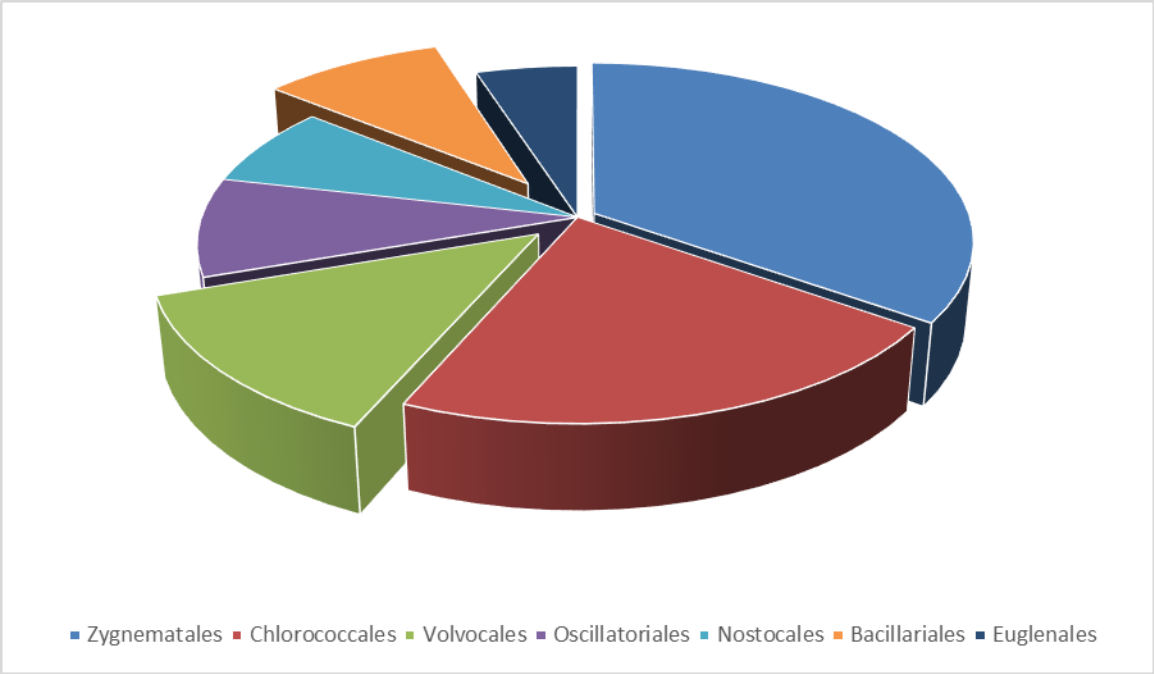

Figure 1: percentage frequency of algal species

Composition of Algal Species

A total of 28 algal species were identified from the study area, belonging to various taxonomic orders and families. These included representatives from Chlorophyta (green algae), Cyanophyta (blue-green algae), Bacillariophyta (diatoms), and Euglenophyta. The species were grouped and classified based on morphology, habitat, habit, order, and family, and their frequency and abundance were recorded accordingly (Table 4.1). Among the green algae, Zygnema spp., Spirogyra spp., Closterium spp., Cosmarium spp., and Micrasterias spp. were prominent, indicating favorable conditions for filamentous and desmidaceous algal growth. Members of the order Chlorococcales such as *Scenedesmus*, *Chlorella*, and *Pediastrum* were also present, suggesting moderate nutrient availability. The presence of *Volvox* and *Eudorina* under the order Volvocales reflects light-rich, stable water conditions suitable for colonial green algae.

Blue-green algae were represented by species from Oscillatoriales (*Oscillatoria*, *Lyngbya*) and Nostocales (*Anabaena*, *Nostoc*), organisms typically tolerant of organic pollution. Diatom

species such as *Navicula*, *Synedra*, and *Nitzschia* under Bacillariales were also recorded, and their presence signifies the influence of varying environmental conditions and potential organic enrichment. *Euglena viridis* from Euglenales was also observed, often regarded as an indicator of high organic matter and pollution.

Distribution by Order and Percentage Abundance

When grouped by taxonomic order, Zygnematales emerged as the most dominant, with 10 species contributing a total of 348 individuals, representing 34.8% of total algal abundance (Table 4.3). This high occurrence underscores the adaptability of filamentous green algae to nutrient-rich environments, often linked with mild eutrophication.

Chlorococcales followed with 6 species and 21.7% abundance, while Volvocales (3 species) accounted for 13.2%. These results suggest that green algae were the most widespread and abundant group in the ecosystem, responding actively to sunlight and moderate nutrient input.

Blue-green algae (Cyanophyta), made up of Oscillatoriales and Nostocales, jointly contributed 16.2% of the total abundance. Their presence is often a signal of increased nitrogen and phosphorus levels from runoff, likely from poultry droppings and organic debris.

Bacillariales (diatoms) made up 9.1% of the total, indicating their tolerance for a wide range of environmental conditions, including slightly polluted waters. Lastly, Euglenales, represented solely by *Euglena viridis*, made up 5.0%, further reinforcing the evidence of organic pollution, possibly linked to sawmill activities and decaying organic matter.

The dominance of green algae, particularly Zygnematales and Chlorococcales, alongside the presence of blue-green algae and euglenoids, points to a moderately eutrophic aquatic environment. These communities reflect the influence of anthropogenic inputs, especially nutrient runoff from poultry and sawmill operations. The composition, frequency, and abundance patterns serve as bioindicators of the ecological status of the freshwater habitat, showing signs of nutrient enrichment with early-stage pollution stress.

Discussion

The study identified a diverse assemblage of freshwater algal species from different taxonomic orders, revealing a dynamic community structure influenced by anthropogenic inputs, particularly sawmill effluents and poultry droppings. A total of 28 algal species were grouped into seven taxonomic orders: *Zygnematales*, *Chlorococcales*, *Volvocales*, *Oscillatoriales*, *Nostocales*, *Bacillariales*, and *Euglenales*. Among these, *Zygnematales* was the most dominant, comprising 10 species and accounting for the highest percentage abundance (34.8%), followed by *Chlorococcales* (21.7%) and *Volvocales* (13.2%). Orders like *Euglenales* and *Nostocales* showed lower abundance, contributing 5.0% and 7.3%, respectively.

The dominance of *Zygnematales*—notably species like *Closterium*, *Gonatozygon*, and *Micrasterias*—suggests that these filamentous and desmid-type algae thrive in nutrient-rich and moderately polluted waters, possibly benefiting from the organic load introduced by sawmill waste and poultry droppings. This aligns with the findings of Sahu et al. 2012, who reported that members of *Zygnematales* are often abundant in moderately eutrophic freshwater systems due to their high tolerance for organic matter.

Similarly, members of the order *Chlorococcales*, such as *Chlorella* and *Pediastrum*, were relatively abundant. These algae are known for their ability to rapidly reproduce in nutrient-enriched environments and are common indicators of organic pollution. Their presence in large numbers is supported by the work of Ogunlaja et al. 2020, who observed high densities of *Chlorococcales* in effluent-receiving streams in southwestern Nigeria.

The moderate representation of *Volvocales* (e.g., *Volvox aureus*) and *Euglenales* (*Euglena*) further reflects the ecological impact of organic pollutants. *Euglena*, in particular, is a known

bioindicator of polluted water and often flourishes in environments high in decaying organic material and nitrogenous compounds. This finding is consistent with Ibrahim and Sulaiman 2018, who reported that *Euglena* species often dominate algal communities in wastewater-polluted ecosystems.

Conversely, the lower representation of *Oscillatoriales* (e.g., *Oscillatoria*) and *Nostocales* (e.g., *Anabaena*) may suggest some sensitivity of these cyanobacteria to specific pollutants or competition from more adaptable chlorophyte algae. However, their presence still indicates some degree of nutrient enrichment and potential for toxin production, especially under eutrophic conditions. *Oscillatoria* and *Anabaena* have been associated with harmful algal blooms (HABs) and oxygen depletion, as documented by Bellinger and Sigee 2010.

Effect of Sawmill Waste and Poultry Droppings

The input of sawmill waste, rich in organic carbon and tannins, may alter the physicochemical parameters of water, such as pH and dissolved oxygen, thus influencing algal growth and community composition. Poultry droppings, high in nitrogen and phosphorus, are likely the main driver of the observed eutrophication, leading to the proliferation of nutrient-loving species. Excessive nutrient loading can result in algal blooms, reduced biodiversity, and potential oxygen depletion, which could harm aquatic fauna and disrupt ecological balance.

These observations underscore the ecological risks associated with unregulated discharge of organic waste into freshwater ecosystems. High algal abundance and the dominance of pollution-tolerant taxa suggest progressive eutrophication and degradation of water quality, which may have far-reaching consequences for aquatic life and human use of such water bodies.

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