International Journal of Innovation and Applied Studies
ISSN 2028-9324 Vol. 46 No. 4 Oct. 2025, pp. 670-675

http://www.ijias.issr-journals.org/

Study of Phytoplankton Composition in the Bays of Plateau, Cocody, Koumassi, and Vridi, Located in the Ébrié Lagoon, Côte d'Ivoire

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ABSTRACT: Most major urban centers in Sub-Saharan Africa are located along the shores of estuaries, lakes, or lagoons which, due to their high biodiversity, are often subjected to significant anthropogenic pressures, particularly waste pollution. This study aims to analyze the phytoplankton community structure of the Ebrié Lagoon, an ecosystem heavily impacted by human activities. Phytoplankton samples were collected between February and November 2020 using a 20-µm mesh plankton net, targeting specific areas of the lagoon exposed to intense anthropogenic pressure. A total of 53 taxa belonging to five phyla were identified: Heterokontophyta, Dinophyta, Cyanoprokaryota, Euglenophyta, and Chlorophyta. Among these groups, Heterokontophyta exhibited the highest diversity, accounting for 58% of the total abundance. Furthermore, Cocody Bay emerged as the most biodiverse site, with 45 species recorded, representing 46% of all identified taxa. These findings highlight the ecological importance of the Ébrié Lagoon as a phytoplankton habitat and emphasize the urgent need for management strategies to safeguard this fragile ecosystem against increasing urbanization.

KEYWORDS: composition, phytoplankton, bays, Ébrié Lagoon, Côte d'Ivoire.

1 INTRODUCTION

Lagoons account for approximately 13% of the world's coastline [1] and are of exceptional ecological and socio-economic importance [2]. They are characterized by high biological richness while simultaneously serving as areas of intense and diverse human exploitation [3]. In addition to receiving freshwater inflows from their watersheds, lagoons are increasingly subjected to the negative impacts of growing anthropogenic pressures [4]. Like many African lagoons, the water quality of the Ébrié Lagoon has markedly deteriorated over the past decades [5]. Anthropogenic stressors on aquatic ecosystems have harmful effects on water quality and on the organisms inhabiting these environments. Among the most affected are phytoplankton communities, whose distribution and abundance are directly influenced by human activities. Phytoplankton play a pivotal role in aquatic ecosystems, acting as primary producers through carbon fixation and serving as a fundamental food source for fish and zooplankton [6], [7]. This study aims to analyze the structure of phytoplankton communities in selected areas of the Ébrié Lagoon, with a view to supporting depollution efforts and the sustainable protection of this fragile ecosystem.

2 MATERIAL AND METHODS

2.1 STUDY AREA

The Ébrié Lagoon, with a surface area of 566 km^2 and an estimated average volume of 2,7.109 m^{3,} is the largest lagoon system in Côte d'Ivoire. It also represents the most extensive coastal ecosystem in West Africa [8], [9]. The lagoon extends over 130 km along the coastline, between 3°40'- 4°50' W longitude and 5°10'–5°20' N latitude. Sampling was conducted at four stations (Fig. 1) distributed across the lagoon: Koumassi (an area of dredging and traditional soap production), Cocody Blockhauss (a densely populated zone with intensive cassava semolina processing), Plateau (near the Lagoon Transport Company, STL), and Vridi Zimbabwe (a port area adjacent to a large fishing community).

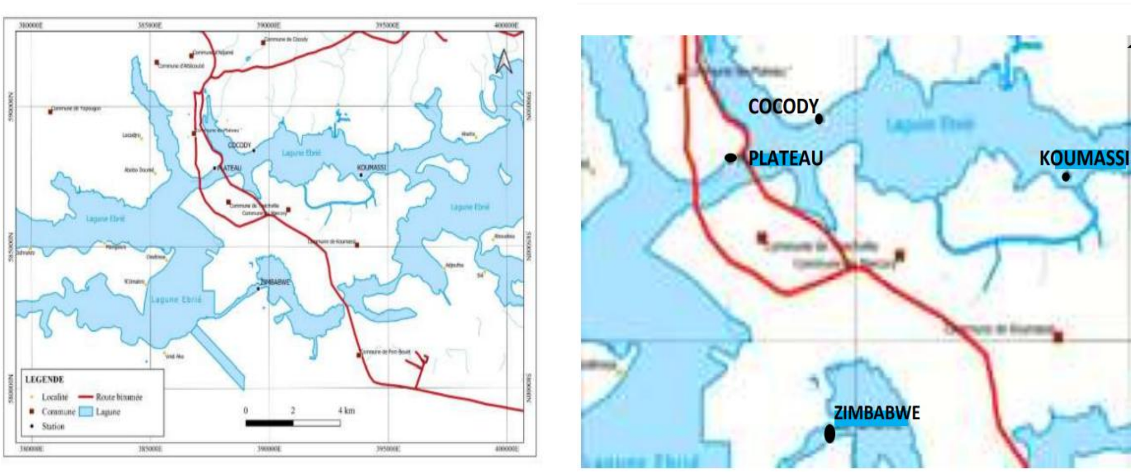

Fig. 1. Sampling Stations in the Ebrié Lagoon, Côte d'Ivoire

2.2 Sampling Of Microalgae

Qualitative sampling of phytoplankton communities was carried out using a plankton net with a 20-µm mesh size at the different stations of the Ébrié Lagoon. Surface water samples were collected with a 15-L bucket and poured ten times through the net to ensure adequate concentration of organisms. The concentrated sample was then drained through the net's outlet into a 33-mL vial specifically prepared for this purpose. Commercial formalin, previously neutralized to eliminate acidity, was added to the vial with a pipette to achieve a final concentration of 5%.

2.3 Observation And Identification Of Microalgae

Observations were conducted in the laboratory. A drop of the sedimented fraction from each vial was collected with a pipette, mounted on a glass slide with a coverslip, and examined under a light microscope (Olympus CXK 41). Phytoplankton species were identified using taxonomic keys and reference works: [10], [11], [12], [13], [14], [15]. Species descriptions followed the classification system established by [16], with additional guidance from the aforementioned authors.

3 Results

Microscopic observations revealed a total of 53 taxa within the phytoplankton population of our study area, categorized into 5 phyla, 7 classes, 27 families, and 34 genera. The Heterokontophyta exhibit the highest diversity, comprising 31 taxa, or 58% of the total count. Following them are the Dinophyta with 9 taxa (17%), Cyanoprokaryota with 6 taxa (11%), Chlorophyta with 4 taxa (8%), and Euglenophyta with 3 taxa (6%) (Fig. 2). Among the 53 phytoplankton taxa documented in the Ebrié Lagoon, 47 were classified as incidental, 5 as accessory, and only 1 as constant (Table 1). The frequency of the incidental taxa included 26 Heterokontophyta, 9 Dinophyta, 5 Cyanoprokaryota, 4 Chlorophyta, and 3 Euglenophyta. In terms of accessory taxa, only 4 Heterokontophyta and 1 Cyanoprokaryota were recorded. The sole constant taxon was found within the Heterokontophyta phylum.

*Table 1. Distribution of taxa by station (FO: Frequency of occurrence; *: Incidental taxa; **: Accessory taxa; ***: Constant taxa)*

Taxons	St1	St2	St3	St4	FO
Cyanoprokaryota					
Cyanophyceae					
Oscillatoriaceae					
Oscillatoria limosa			x	x	*
Oscillatoria anguinis	x	x	x		**
Oscillatoria sp.	x	x			*
Spirulina major	x	x			*
Chroococcaceae					
Chroococcus dispersus		x	x		
Microcystis sp.	x		x		*

Heterokontophyta					
Coscinodiscophyceae					
Melosiraceae					
Aulacoseira sp.		x	x	x	**
Melosira italica		x	x		*
Heliopeltaceae					
Actinoptychus adriaticus			x	x	*
Coscinodiscaceae					
Coscinodiscus asteromphalus	x	x	x	x	***
Coscinodiscus marginatus	x	x	x	x	***
Coscinodiscus sp.	x		x		*
Rhizosoleniaceae					
Rhizosolenia bergonii			x		*
Guinardia flaccida			x		*
Guinardia striata		x			*
Pseudosolenia calcar-avis			x		*
Skeletonemaceae					
Skeletonema costatum	x	x	x	x	***
Mediophyceae					
Anaulaceae					
Terpsinoe musica		x	x		*
Attheyaceae					
Attheya sp.			x		*
Bellerocheaceae					
Climacodium frauenfeldianum			x		*
Chaetocerotaceae					
Chaetoceros brevis			x		*
Chaetoceros curvisetus			x	x	*
Chaetoceros compressus			x	x	*
Chaetoceros decipiens			x	x	*
Chaetoceros lauderi			x		*
Chaetoceros subtilis			x	x	*
Chaetoceros sp.1			x		*
Chaetoceros sp.2		x	x		*
Chaetoceros sp.3			x		*
Hemiaulaceae					
Hemiaulus sp.			x		*
Lauderiaceae					
Lauderia annulata		x			*
Triceratiaceae					
Odontella sinensis			x		*
Paraliaceae					
Paralia sp.	x	x	x		*
Bacillariophyceae					
Naviculaceae					
Donkinia sp.	x				*
Pleurosigmataceae					
Gyrosigma balticum	x			x	*
Surirellaceae					
Surirella sp.1	x	x	x		**

Surirella sp.2			x	x	*
Euglenophyta					
Euglenophyceae					
Euglenales					
Euglenaceae					
Phacus longicauda			x	x	
Euglena proxima	x				
Trachelomonas scabra	x		x		*
Chlorophyta					
Chlorophyceae					
Chlorococcales					
Hydrodictyaceae					
Pediastrum duplex	x		x		
Scenedesmaceae					
Coelastrum sp.			x		*
Desmodesmus disciformis			x	x	*
Desmodesmus quadricauda			x		*
Dinophyta					
Dinophyceae					
Protoperidiniaceae					
Protoperidinium sp.1			x	x	*
Protoperidinium sp.2	x		x		*
Protoperidinium sp.3			x	x	*
Pyrophacaceae					
Pyrodinium sp.			x	x	*
Dinophysaceae					
Dinophysis caudata		x		x	*
Dinophysis rotundata		x	x		*
Prorocentraceae					
Prorocentrum micans		x	x		*
Ceratiaceae					
Ceratium furca			x	x	*
Podolampadaceae					
Podolampas sp.			x	x	*
Total = 53	**15**	**18**	**45**	**20**	

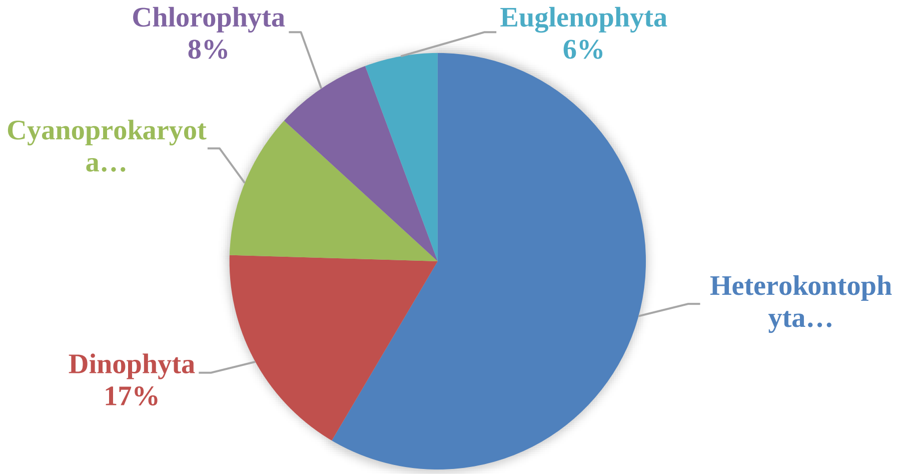

Fig. 2. Proportion of the different phyla observed in the Ebrié Lagoon

In terms of the spatial distribution of taxa (Fig. 3), the highest number (45 taxa or 46%) was recorded at station 3 (Cocody Bay). Station 4 recorded 20 taxa (21%), station 2 recorded 18 taxa (18%), and finally, station 1 recorded 15 taxa (15%). The values of the Jaccard similarity index coefficient ranged between 0.15 and 0.27. The highest value (0.27) was observed between stations 2 and 4, with 6 common taxa. The lowest index (0.15) was recorded between stations 1 and 3, with 7 common taxa.

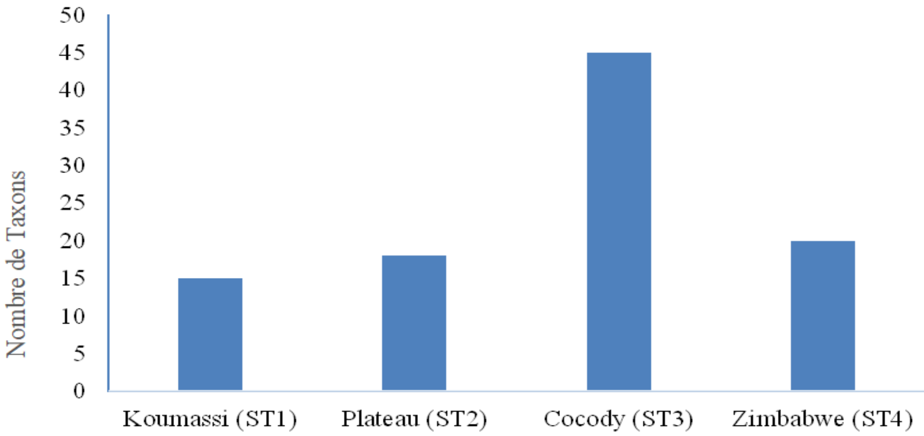

Fig. 3. Distribution of taxa based on sampling stations

4 DISCUSSION

The study of phytoplankton communities in the Ebrié Lagoon identified a total of 53 taxa. These numbers can be considered quite low in terms of species richness when compared to the work of [17] and [14], who documented 138 and 122 taxa, respectively, in the same lagoon. This limited diversity may be attributed to a short sampling duration as well as unfavorable conditions for certain phytoplankton groups, such as Chlorophyta and Euglenophyta. Indeed, extreme variations in physicochemical parameters, including pH, salinity, and temperature, can restrict the survival of certain phytoplankton species. Temperature fluctuations, for instance, can impact the life cycles and reproduction of algae [18]. The observed low diversity could also be explained by the alteration of aquatic habitats due to human activities, such as urbanization, which may create unfavorable conditions for phytoplankton. Habitat destruction and changes in hydrological regimes can lead to reduced diversity [19]. The phytoplankton composition showed a dominance of Heterokontophyta, likely due to the influx of freshwater from rivers that have introduced these diatoms into the lagoon system. In fact, the freshwater bodies in Côte d'Ivoire are rich in various diatoms [20]. Studies conducted by [17] and [14] on the Ebrié Lagoon also reported a dominance of Heterokontophyta. However, when extending this comparison to the work of [21] on the same lagoon, it was found that Cyanophyta were more predominant. Additionally, research by [22] in a lagoon in Lagos also demonstrated a dominance of Heterokontophyta. Overall, our findings indicate that the phytoplankton community is predominantly represented by marine taxa. The Ebrié Lagoon is characterized as an open system (parallel to the marine environment), where the influence of marine waters is significant [14], potentially facilitating the influx of marine taxa into the lagoon. The opening of the Vridi Canal further explains this abundance of marine taxa. The presence of a few freshwater species can be attributed to the influence of freshwater from the Comoé River and the Mé and Agnéby Rivers, which has favored the presence of these freshwater organisms. The frequency of occurrence analysis revealed that the majority of taxa collected from the Ebrié Lagoon were incidental. This abundance of incidental taxa may be due to the fact that most of the collected taxa were introduced via runoff, fishing net transport, or detachment from fixed taxa. In contrast, constant taxa were able to adapt to the varying physicochemical characteristics of the environment. The presence of accessory taxa can be justified by the strong pressure from human activities that alter environmental parameters, preventing these taxa from remaining consistently in the lagoon. The similarity index values were low, remaining below 0.5, indicating a high degree of heterogeneity within the algal community. This could be attributed to the selection of sampling sites based on the diverse anthropogenic activities that vary from one site to another, generating different effluents that can influence the development of algal taxa.

5 CONCLUSION

This study has enhanced our understanding of the phytoplankton community in the Ebrié Lagoon, revealing the richness and relative diversity of this aquatic ecosystem. In total, we documented 53 taxa distributed across 5 phyla, 7 classes, 27 families, and 34 genera. Among them, Heterokontophyta stands out as the most diverse phylum, representing 58% of the total count with 31 taxa. This is followed by Dinophyta with 9 taxa, Cyanoprokaryota with 6 taxa, Chlorophyta with 4 taxa, and finally Euglenophyta with 3 taxa. This analysis highlights the importance of the Ebrié Lagoon as a habitat for phytoplankton, underscoring the need for further research to better understand the ecological dynamics of this lagoon.

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