



Composition, Distribution and Spatio-Temporal Dynamics of Phytoplankton Community of the Tropical Freshwater Stream, Ikoro Stream, Edo State, Nigeria.

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ABSTRACT: The objective of this paper is to investigate the Composition, Distribution and Spatio Temporal Dynamics community of the tropical freshwater stream, Ikoro Stream, Edo State, Nigeria using appropriate standard methods. A total of 83 phytoplankton taxa comprising five taxonomic divisions, namely Chlorophyta (55%), Bacillariophyta (32%), Cyanophyta (7%), Euglenophyta (5%) and Rhodophyta (1%) were identified. The Chlorophyta were mainly Desmidiaceae; Bacillariophyta were mainly Diatomaceae and Naviculaceae; Cyanophyta represented by Chroococcaceae, Nostocaceae, and Oscillatoriaceae; Euglenophyta represented by Euglenophyceae and Rhodophyta by the single species *Batrachospermum vagum*. *Fragillaria* sp. was identified as the most ubiquitous taxon, with an overwhelming 96% occurrence across almost all sampling months and stations. Other highly frequent taxa included *Surirella elegans* (67%), *Pinnularia cardinaliculus* (63%), and *Cladophora oligoclona* (54%). Conversely, Chlorophyta richness was heavily driven by true desmids (e.g., *Closterium*, *Cosmarium*, and *Micrasterias*), alongside filamentous forms such as *Spirogyra* and *Oedogonium*. Spatio-temporal dynamics were influenced by seasonal climate shifts. Spatial variations were minor, though Station 3 displayed a slightly more robust distribution of desmids and euglenoids later in the sampling season. From a bio-indicator perspective, the minimal presence of organic pollution markers - specifically Cyanophyta (*Anabaena*, *Oscillatoria*) and Euglenophyta (*Euglena*, *Phacus*) indicates that Ikoro Stream is relatively pristine and free from heavy agricultural or anthropogenic eutrophication. This ecological integrity is further corroborated by the presence of the red alga *Batrachospermum vagum* (21% occurrence), a sensitive indicator of clean, well-oxygenated, flowing lotic systems. On the whole, the study demonstrates that Ikoro Stream maintains a stable ecological balance, providing crucial baseline data for local watershed conservation and management.

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Phytoplankton are microscopic algae that float freely in water and can only move passively due to currents and waves. (Kadiri and Akhere 2021). They are commonly categorized on the basis of size into five classes: ultraplankton less than 2µm in diameter, nanoplankton 2 to 20µm, microplankton 20 to 200µm, macroplankton 200 to 2000µm and megaplankton greater than 2000 µm (Carol *et al*, 1993; Opute and

Kadiri, 2013). Phytoplankton are dominant plants in limnetic well-lit regions of aquatic ecosystem; therefore, their role in the aquatic environments is of paramount importance. As primary producers in the aquatic system phytoplankton are responsible for the conversion of inorganic materials into organic matter. Thus, they constitute the principal initiator of the biomass conversion and food of aquatic fauna either

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directly or indirectly. The abundance and spread of phytoplankton are in direct relationship to the health, physico-chemical status as well as aging process of the host aquatic ecosystems (Pereira, 2025). Complex interactions between physicochemical variables, including nutrient availability, light intensity, temperature, pH, hydrological conditions, and the extent of anthropogenic disturbance, control the organization of phytoplankton communities (Etisa *et al* 2024, Akin-Orinola, 2003). These parameters ultimately determine species composition and relative abundance. Phytoplankton assemblages are frequently dominated by taxa like Bacillariophyta and Chlorophyta under favourable environmental conditions (Zhang *et al* 2025). However, restricted water flow and nutrient enrichment frequently encourage the growth of cyanobacteria, some of which can produce toxins that are detrimental to aquatic life and human health (Dokulil and Teubner, 2000). Ikoro Stream, located in Edo State, Nigeria, is a freshwater lotic ecosystem that supports domestic activities, agriculture, and other ecological functions for nearby communities. Despite its socio-economic significance, limited information exists regarding the ecology and composition of its phytoplankton communities. Considering the potential impacts of riparian farming, waste disposal, and seasonal flooding, anthropogenic disturbances may alter nutrient dynamics and subsequently affect phytoplankton community structure. Such ecological changes could have significant implications for water quality and the sustainability of ecosystem services provided by the stream. The objective of this paper is to investigate the Composition, Distribution and Spatio Temporal

Dynamics community of the tropical freshwater stream, Ikoro Stream, Edo State, Nigeria.

MATERIALS AND METHODS

Description of Study Area: The study was carried out on Ikoro Stream, located at Ikoro village in Ovia North East Local Government Area of Edo State, Nigeria. It is a tributary of Osse River and it lies between latitude $5^{\circ} 25' \text{ E}$ and $5^{\circ} 30'$ and longitude $6^{\circ} 15' \text{ N}$ and $6^{\circ} 19' \text{ N}$. Climatically, they are having two seasons - the dry season (November - April) and the wet season (May – October).

Sampling Stations: Three sampling locations were earmarked for the study as shown in figure 1.

Station One: Station one (1) is located close to the bank of the stream where trading on aquatic foods, bathing and washing of clothes take place. On the fringes of this stations are grasses like *Commelina benghalensis*, *Elaeis guineensis* and epiphytes.

Station Two: Station two (2) is about 100m from station1. This station is used as a source of drinking water for the inhabitants of Ikoro village. The vegetation here are mainly *Commelina Benghalensis* and *Dryopteris*: Human activities such as washing and bathing also take place here.

Station Three: Station three (3) is about 300m from station 2; fishing activities take place here and the dominant plant species are *Elaeis guineensis* and ferns.

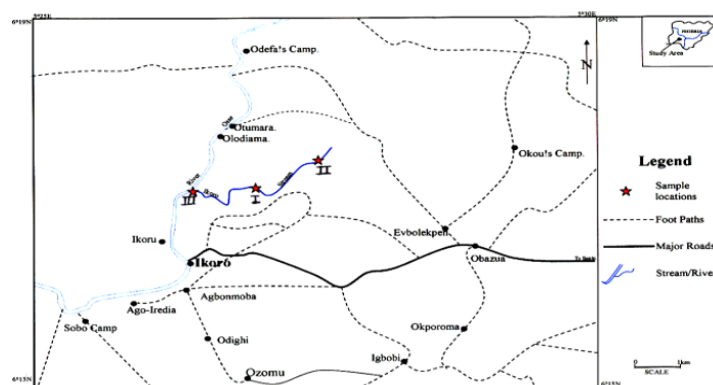


Figure 1: Map of Study Area Showing the Sample Locations along Ikoro Stream

Collection of Samples: The sampling was carried out at monthly intervals for a period of eight months, from the three stations. Phytoplankton samples were collected in each of the sampling stations by towing a 55µm mesh plankton net through the water. The samples were put into clean plastic containers and preserved using 4% formalin solution.

Microscopic Examination, Photography, and Identification: Aliquots of the samples were examined and photographs taken by using a Leitz Orthoplan Wide Field research microscope. Identification was done using Prescott (1975), Kadiri (1987), Opute (1991) and Belling and Sigee (2015).

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RESULTS AND DISCUSSION

The phytoplankton flora of the three stations studied in Ikoro stream consist of eighty-three taxa comprising of five divisions, thirteen orders, twenty-one families, thirty-nine genera. Division Chlorophyta and Bacillariophyta had 55% (46 taxa) and 32% (26 taxa) respectively which constituted majority of the entire phytoplankton as shown in table 1. These were followed by Cyanophyta which contributed 7% (6 taxa), then Euglenophyta 5% (4 taxa) and the least was Rhodophyta which contributed 1% (1 taxon) to the total phytoplankton population as shown in figure 2.

Table 2 illustrates the spatio-temporal distribution and percentage occurrence of phytoplankton (algal genera) recorded across three distinct stations in Ikoro Stream over an eight-month sampling period (February to September). The phytoplankton community represented by five major taxonomic divisions of Bacillariophyta, Chlorophyta, Cyanophyta, Euglenophyta, and Rhodophyta, reveal the following findings: Bacillariophyta (Diatoms) exhibits the highest variety of taxa and is the most consistently distributed division across all stations and months. Notable genera include *Cymbella*, *Eunotia*, *Fragillaria*, *Frustulia*, *Aulacoseira*, *Pinnularia*, *Surirella*, *Ulnaria*, and *Tabellaria*. Chlorophyta (green algae) were found in all three stations with the exception of *Scenedesmus apiculatus*, which occurred only in station 3 in the months of February and March and *Cosmarium binum* which occurred in station 1 in the month of February. This division consists of the highest number of individual species/genera recorded, dominated substantially by desmids, particularly true desmids (Desmidiaceae), such as *Closterium*, *Cosmarium*, *Desmidium*, and *Micrasterias*, alongside filamentous Zygnematophyceal forms like *Spirogyra*, *Mougeotia*, and *Oedogonium*.

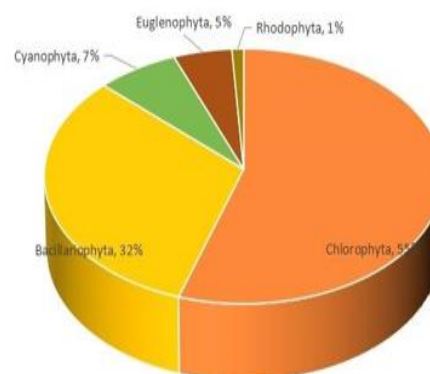


Fig. 2: Relative Contribution of Phytoplankton Divisions of Ikoro Stream

Six Orders and nine Families represented the division Chlorophyta. The Orders were Chlorococcales, Oedogoniales, Ulothrichales, Cladophorales, Volvocales and Zygnematales. The families were Scenedesmaceae, Oedogoniaceae, Ulothrichaceae, Cladophoraceae, Volvocaceae, Zygnemataceae, Mesotaeniaceae and Desmidiaceae. The order Zygnemataceae made up the bulk of Chlorophyta with 37 taxa out of the total Chlorophyta taxa of 46. Amongst the Bacillariophyta, the Centrales comprised members belonging to Families Melosiraceae and Eupodiscaceae with only one taxon representing each of these families. The Pennales group was represented by the following families: Diatomaceae, Eunotiaceae, Naviculaceae and Surirellaceae. The following three families: Naviculaceae (12 taxa) and Diatomaceae (7 taxa) were better represented than others. Cyanophyta was represented by 3 Orders. These were Chroococcales, Nostocales and Oscillatoriales comprising of the following families: Chroococceae (1 taxon), Nostocaceae (1 taxon) and Oscillatoriaceae (4 taxa). The Rhodophyta was represented by only one Order (Nemalionales) and one family (Batrachospermaceae) as shown in table 1.

Table 1: Phytoplankton Composition of Ikoro Stream

Division	Classes	Orders	Families	Genera	Species	Total	% Taxa Composition
Chlorophyta	Chlorophyceae	6	9	23	46	46	55
Bacillariophyta	Bacillariophyceae	2	6	11	22	26	32
Cyanophyta	Cyanophyceae	3	3	4	6	6	7
Euglenophyta	Euglenophyceae	1	1	2	4	4	5
Rhodophyta	Rhodophyceae	1	1	1	1	1	1
Total	5	13	20	42	79	83	100

Table 2: Spatio-temporal Distribution of Phytoplankton of Ikoro Stream for station 1

ALGAL GENERA	STATION 1								Total % Occurrence
	February	March	February	May	February	July	February	September	
Bacillariophyta									
<i>Cymbella</i> sp	-	+	-	-	-	-	-	-	4
<i>Eunotia asterionelloides</i> Hustd	-	+	-	+	+	+	-	-	17
<i>Eunotia flexulosa</i> Brebex Kutz	+	-	-	-	-	-	-	-	21
<i>Fragillaria</i> sp.	+	+	+	+	+	+	+	+	96
<i>Frustulia rhomboides</i> Her.D De Toni	-	-	-	+	+	-	+	-	38
<i>Aulacoseira</i> sp.	+	-	-	-	-	-	-	-	4

<i>Aulacoseira granulata</i> (Ehr.) Ralf var <i>muzzanesis</i> (Meist)+	-	+	+	+	-	-	+	-	38
<i>Pinnularia cardinaliculus</i> Cleve (one cell)	-	-	+	+	+	+	+	+	63
<i>Pinnularia cardinaliculus</i> Cleve (two-celled)	-	-	-	+	-	-	-	-	13
<i>Pinnularia cardinaliculus</i> Cleve (three-celled)	-	-	+	-	-	-	-	-	29
<i>Pinnularia cardinaliculus</i> Cleve (four-celled)	-	-	-	-	-	+	-	-	13
<i>Pinnularia nobilis</i> Ehr.	-	-	-	-	-	+	-	-	13
<i>Pinnularia rivularis</i> Hustedt	-	-	-	+	+	-	-	-	33
<i>Pinnularia viridis</i> (Nitzsch) Ehr.	-	-	+	+	+	+	-	-	54
<i>Surirella celebesiana</i> Hustedt	-	-	-	-	-	+	-	-	4
<i>Surirella elegans</i> Ehr.	-	+	+	+	+	+	+	-	67
<i>Surirella robusta</i> Ehr.	-	-	-	-	-	-	-	+	4
<i>Surirella sublinearis</i> Hust.	-	-	+	+	+	-	-	-	38
<i>Ulnaria acus</i> Kutz	-	+	+	-	-	-	-	-	21
<i>Ulnaria superba</i> Kutz	-	+	-	+	+	-	-	-	29
<i>Tabellaria fenestrata</i> (Lyngb) Kutz	-	-	-	-	-	-	+	-	21
<i>Tabellaria flocculosa</i> var <i>asterionelloides</i> (Rothe) Kutz	-	-	-	-	-	-	+	-	25
<i>Tabellaria flocculosa</i> (Rothe) Kutz	+	-	+	-	+	+	+	-	46
CHLOROPHYTA									
<i>Chamydomonas</i> sp	-	+	-	-	-	-	-	+	17
<i>Cladophora oligoclona</i> Kutz	-	-	+	+	-	-	+	-	54
<i>Closterium acerosum</i> (Schrank) Ehr Ex Ralf	-	-	-	-	+	+	+	-	42
<i>Closterium diane</i> Ehr.var <i>arcuatum</i> (Breb.) Raben	-	-	-	-	-	+	-	-	17
<i>Closterium lunata</i> (Mull.) Nitzsch	-	+	-	-	-	-	-	-	4
<i>Cosmarium askenasiyi</i> Schmidle Scot and Prescott	-	-	-	+	-	-	-	-	17
<i>Cosmarium binum</i> Nordst	+	-	-	-	-	-	-	-	4
<i>Cosmarium decoratum</i> West and West	+	+	-	-	+	-	-	-	29
<i>Cosmarium monodii</i> Bourrelly	-	+	-	-	-	-	+	+	21
<i>Cosmarium</i> sp	+	-	-	-	-	-	-	-	13
<i>Desmidium coarctatum</i> Nordst.	-	+	-	+	-	-	-	-	21
<i>Desmidium swartzii</i> Agard	+	+	-	-	-	-	-	+	21
<i>Desmogonium rabenhorstianum</i> var <i>elongatum</i> Patr.	+	+	+	-	-	-	-	+	25
<i>Eudorina elegans</i> Ehr.	-	-	+	-	-	-	-	-	8
<i>Gonatozygon kinahanii</i> (Arch)	-	+	+	-	-	-	-	-	8
Rabenh.f. <i>minor</i> Foster	-	-	-	-	-	-	-	-	-
<i>Micrasterias doveri</i> (Biswas) var <i>africana</i> Bourrelly	-	-	+	-	-	-	-	-	8
<i>Micrasterias foliaceae</i> Bailey	-	-	-	-	-	+	+	-	4
<i>Micrasterias monahabuleshwariensis</i> Hobs	-	-	-	+	-	-	-	-	4
<i>Micrasterias torreyi</i> Bail	-	+	-	-	-	-	-	+	13
<i>Mougetia sphaerocarpa</i> Wolle	+	-	-	-	-	-	-	-	25
<i>Mougetia</i> sp	+	-	-	-	-	-	-	-	13
<i>Netrium digitus</i> var <i>digitus</i> (Ehr.) Itzigs & Rothe	-	+	-	+	-	-	-	-	8
<i>Oedogonium grande</i> Kutz	+	-	-	-	-	-	-	-	8
<i>Oedogonium suecicum</i> Wittr.	+	-	+	-	-	-	-	-	29
<i>Pandorina</i> sp	-	-	+	-	-	-	-	-	8
<i>Pleurotaenium coronulatum</i> (Breb)	-	-	+	-	-	-	-	-	8
<i>Pleurotaenium fluctuatum</i> W. West	-	-	-	-	-	-	-	-	-
<i>Pleurotaenium subcoronulatum</i> (Turn)	-	-	+	-	-	-	-	-	8
<i>Pleurotaenium ovatum</i> Nordst	-	-	-	-	-	-	-	+	8
<i>Spirogyra insignis</i> (Hass) Kutz	-	-	-	+	-	-	-	-	17
<i>Spirogyra</i> sp	+	-	-	-	-	-	-	-	25
<i>Spharozosma granulatum</i> Roy and Bliss	+	-	-	+	-	-	-	-	25
<i>Straurastrum setigerum</i> Cleve	+	-	-	-	-	-	-	-	13
<i>Tetmemorus brebissonii</i> (Menegh) Ralfs	-	-	-	+	-	-	-	-	8
<i>Ulothrix tenuissima</i> Kutz	+	+	-	-	-	-	+	-	38
<i>Vovlox Africana</i> Ehr.	-	-	-	-	-	-	-	+	8
<i>Zygnema pectinatum</i> (Vauch) C. A. Agardh	-	-	-	-	+	-	-	-	8
DIVISION CYANOPHYTA									

<i>Anabaena</i> sp	+	-	-	-	-	-	-	-	8
<i>Lyngbia aestuari</i> (Martens) Liebman	-	-	-	+	-	-	-	-	4
<i>Lyngbia majuscula</i> Harvey	-	-	-	+	-	-	-	-	8
<i>Oscillatoria limnosa</i> Agardh	-	-	-	-	+	-	-	-	8
DIVISION EUGLENOPHYTA									
<i>Eglena</i> sp	+	+	-	-	-	+	-	-	25
<i>Phacus longicauda</i> Duj.	+	+	-	-	-	+	-	-	25
DIVISION RHODOPHYTA									
<i>Batrachospermum vagum</i> (Rothe) C.	-	-	-	+	-	-	+	-	21
<i>Agardh var vagum</i>									

+ means present - means absent

Cyanophyta, Euglenophyta, and Rhodophyta are minor components of the phytoplankton flora, represented by only a few genera each (e.g., *Anabaena* and *Oscillatoria* for Cyanophyta; *Euglena* and *Phacus* for Euglenophyta; *Batrachospermum* for Rhodophyta). The Most Ubiquitous Taxon is *Fragillaria* sp. which is the single most dominant organism in Ikoro Stream, commanding a staggering

96% occurrence. It was captured in almost every single sampling month across all three stations, showing only a few sporadic absences (such as June in Station 2) as shown in table 2. Other highly frequency phytoplankton include *Surirella elegans* (67%), *Pinnularia cardinaliculus* (one-celled form, 63%), *Pinnularia viridis* (54%), and *Cladophora oligoclona* (54%).

Table 2: Spatio-temporal Distribution of Phytoplankton of Ikoro Stream for station 2

ALGAL GENERA	STATION 2								Total Occurrence	% Occurrence
	February	March	April	May	June	July	August	September		
BACILLARIOPHYTA										
<i>Eunotia asterionelloides</i> Hustd			+	+	+					17
<i>Eunotia flexulosa</i> Brebex Kutz	+		+	+						21
<i>Fragillaria</i> sp.	+	+	+	+		+	+	+		63
<i>Fragillaria javanica</i> (Hustedt)			+							4
<i>Frustulia rhomboides</i> Her.D De Toni				+		+	+	+		38
<i>Aulacoseira granulata</i> (Ehr.) Ralf	+									38
var <i>muzzanesis</i> (Meist)										
<i>Pinnularia cardinaliculus</i> Cleve (one cell)			+		+		+			63
<i>Pinnularia cardinaliculus</i> Cleve (two-celled)		+								13
<i>Pinnularia cardinaliculus</i> Cleve (three-celled)	+		+		+	+				29
<i>Pinnularia cardinaliculus</i> Cleve (four-celled)					+					13
<i>Pinnularia nobilis</i> Ehr.				+						13
<i>Pinnularia rivularis</i> Hustedt			+		+					33
<i>Pinnularia viridis</i> (Nitzsch) Ehr.			+	+	+	+	+			54
<i>Surirella elegans</i> Ehr.	+	+		+	+	+	+			67
<i>Surirella sublinearis</i> Hust.		+	+	+						38
<i>Ulnaria acus</i> Kutz						+				21
<i>Ulnaria superba</i> Kutz			+		+					29
<i>Tabellaria fenestrata</i> (Lyngb) Kutz			+							21
<i>Tabellaria floculosa</i> var <i>asterionelloides</i> (Rothe) Kutz			+				+			25
<i>Tabellaria floculosa</i> (Rothe) Kutz				+	+					46
CHLOROPHYTA										
<i>Chamydomonas</i> sp		+								17
<i>Cladophora oligoclona</i> Kutz			+	+	+	+				54
<i>Closterium acerosum</i> (Schrank) Ehr					+	+				42
Ex Ralf										
<i>Closterium diane</i> Ehr.var <i>arcuatum</i> (Breb.) Raben							+			17
<i>Closterium monoliferum</i> (Borg.) Ehr.		+	+							8
<i>Closterium turgidum</i> Ehr.			+							4
<i>Cosmarium askenasiyi</i> Schmiddle		+						+		17
Scot and Prescott										
<i>Cosmarium decoratum</i> West and West	+									29
<i>Cosmarium</i> sp	+	+								13

<i>Desmidium coarctatum</i> Nordst.	+	-	-	-	-	-	-	-	21
<i>Euastrum pseudopectinatum</i> Schmidle	-	-	+	-	-	-	-	-	8
<i>Micrasterias fimbriata</i> Ralfs	+	-	-	-	-	-	-	-	13
<i>Mougetia sphaerocarpa</i> Wolle	-	-	-	-	-	+	+	-	25
<i>Oedogonium suecicum</i> Wittr.	-	-	-	-	-	+	-	-	29
<i>Pleurotaenium ovatum</i> Nordst	-	-	+	-	-	-	-	-	8
<i>Spirogyra insignis</i> (Hass) Kutz	-	+	+	-	-	-	-	-	17
<i>Spirogyra</i> sp	+	+	-	-	-	-	+	-	25
<i>Spharozosma granulatum</i> Roy and Bliss	+	-	-	-	-	+	-	-	25
<i>Straurastrum setigerum</i> Cleve	-	-	-	-	-	-	+	-	13
<i>Tetmemorus brebissonii</i> (Menegh) Ralfs	-	-	-	+	-	-	-	-	8
<i>Ulothrix tenuissima</i> Kutz	+	-	-	+	-	-	+	-	38
DIVISION CYANOPHYTA									
<i>Anabaena</i> sp	+	-	-	-	-	-	-	-	8
<i>Lyngbia majuscula</i> Harvey	-	-	-	+	-	-	-	-	4
<i>Lyngbia</i> sp	-	+	-	-	-	-	-	-	4
DIVISION EUGLENOPHYTA									
<i>Euglena oxyuris</i> Schmarida	-	-	-	-	+	-	-	-	17
<i>Euglena</i> sp	-	+	-	-	-	-	-	-	25
<i>Phacus longicauda</i> Duj.	-	+	-	-	-	-	-	-	25

+ means present - means absent

A significant portion of the flora is rare, yielding only a 4% occurrence rate. These are typically restricted to a single station during a specific month—examples include *Cymbella* sp. (Station 1, March), *Pinnularia dactylus* (Station 3, July), *Cosmarium binum* (Station 1, February), and *Euglena acus* (Station 3, August) shown in table 2. Temporal variations indicate total phytoplankton presence fluctuates profoundly by month. For many species, occurrence drops or becomes highly fragmented during the peak wet season months (June/July), while certain diatoms like *Fragillaria* sp. maintain a steady presence regardless of the season. For spatial variations, Station 3 (table 2) displays a slightly more robust distribution for several desmid species (*Closterium acerosum*, *Closterium diane*) and euglenoids later in the sampling season (July–September) compared to Stations 1 and 2.

The phytoplankton community of Ikoro Stream is structurally dominated by two major groups: Bacillariophyta and Chlorophyta, a trend frequently observed in tropical lotic (flowing water) ecosystems (Ismail and Hamid, 2023).

The Ubiquity Dominance of Diatoms (Bacillariophyta) shown by the overwhelming persistence of diatoms, particularly *Fragillaria* sp. (96% occurrence) and *Surirella elegans* (67% occurrence), indicates that the environmental conditions of Ikoro Stream are highly favourable for silica utilizing organisms. Diatoms are well-adapted to flowing water environments because many species possess mechanisms to tolerate turbulence, varying light conditions, and rapid nutrient fluctuations (Pal and Choudhury, 2014). The high occurrence of

Pinnularia and *Surirella* species - which are frequently benthic or periphytic and this suggests that stream mixing or shallow depths may routinely suspend these organisms into the open water column, a physical process typical of shallow lotic environments (Arévalo-Moreno *et al.*, 2026). The cosmopolitan distribution of these taxa indicates that they can survive in varied environmental conditions both chemical and physical. While diatoms dominate in sheer consistency and occurrence, Chlorophyta dominates in species richness, heavily driven by desmids (e.g., *Closterium*, *Cosmarium*, *Micrasterias*). The dominance of the Ikoro Stream by largely green algae, particularly desmids are typical of freshwater (Kadiri, 2000b; Kilham and Hecky 1988 and Mustapha, 2008). Desmids occupy a wide range of ecological niches (Moss 1996, Karunya and Krishnakumar 2021). This probably account for their occurrence in all the stations though a few were restricted to one or two stations. The genera *Closterium*, *Cosmarium* and *Micrasterias* were impressively distributed and their distribution indicates their position in productivity and sustenance of the ecosystem. In limnology, a high diversity of desmids is classically indicative of freshwaters that are oligotrophic to mesotrophic (low to moderate nutrient levels) and typically acidic to neutral in pH (Magner, 2022).

The presence of filamentous green algae like *Spirogyra* and *Oedogonium* further highlights a healthy, unpolluted, or weakly enriched lotic habitat where these algae can anchor or form loose mats. The order of dominance of the Phytoplankton groups of Chlorophyta > Bacillariophyta > Cyanophyta >

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Euglenophyta > Rhodophyta is in consonance with the work of Adeniyi and Akinwale (2017), Kefas *et al.* (2025), Mohammed *et al.* (2020), Idowu *et al.* (2018). However, Chindah and Pudo (1991), Streekumar and Joseph (1995) reported that the Bacillariophyta are the dominant forms in fresh water body.

The diversity and distribution observed for the division Chlorophyta, can be favourably compared with the report of Opute (1990) which recorded particularly

high species diversity in the division Chlorophyta of phytoplankton flora of the Warri/Forcados Estuary of Southern Nigeria. Since phytoplankton are principally the primary producers in the aquatic food chain, dominant divisions-Chlorophyta and Bacillariophyta, are integral to the sustainable productivity of the Ikoro Stream ecosystem, for the eventual colonization by other relatively more discriminate species, such as the members of the Euglenophyta and Rhodophyta.

Table 2: Spatio-temporal Distribution of Phytoplankton of Ikoro Stream for station 3

ALGAL GENERA				STATION 3						Total Occurrence	%
				February	March	April	May	June	July		
BACILLARIOPHYTA											
<i>Eunotia asterionelloides</i> Hustd	-	-	+	-	-	-	-	-	-	17	
<i>Eunotia flexulosa</i> Brebex Kutz	-	-	-	+	-	-	-	-	-	21	
<i>Fragillaria</i> sp.	+	+	+	+	+	+	+	+	+	96	
<i>Fragillaria javanica</i> (Hustedt)	-	-	-	+	-	-	-	-	-	4	
<i>Frustulia rhomboides</i> Her.D De Toni	-	-	+	-	-	-	-	-	-	-	
<i>Aulacoseira granulata</i> (Ehr.) Ralf var <i>muzzanesis</i> (Meist)	+	+	-	+	-	-	-	-	-	38	
<i>Pinnularia cardinaliculus</i> Cleve (one cell)	-	+	+	+	+	+	+	-	-	63	
<i>Pinnularia cardinaliculus</i> Cleve (two-celled)	-	-	+	-	-	-	-	-	-	13	
<i>Pinnularia cardinaliculus</i> Cleve (three-celled)	+	-	-	+	-	-	-	-	-	29	
<i>Pinnularia cardinaliculus</i> Cleve (four-celled)	-	-	-	-	-	-	-	+	-	13	
<i>Pinnularia dactylus</i> Ehr.	-	-	-	-	-	+	-	-	-	4	
<i>Pinnularia nobilis</i> Ehr.	-	-	+	-	-	-	-	-	-	13	
<i>Pinnularia rivularis</i> Hustedt	-	+	+	+	-	+	-	-	-	33	
<i>Pinnularia viridis</i> (Nitzsch) Ehr.	-	+	+	+	-	-	+	-	-	54	
<i>Surirella elegans</i> Ehr.	-	+	+	+	-	-	+	-	-	67	
<i>Surirella sublinearis</i> Hust.	-	-	+	+	+	-	-	-	-	38	
<i>Ulnaria acus</i> Kutz	-	-	+	-	-	+	-	-	-	21	
<i>Ulnaria superba</i> Kutz	-	-	+	-	-	+	-	-	-	29	
<i>Tabellaria fenestrata</i> (Lyngb) Kutz	-	-	+	-	+	-	+	-	-	21	
<i>Tabellaria floculosa</i> var <i>asterionelloides</i> (Rothe) Kutz	-	-	+	-	+	-	+	-	-	25	
<i>Tabellaria floclossa</i> (Rothe) Kutz	+	-	-	+	+	-	+	-	-	46	
CHLOROPHYTA											
<i>Chamydomonas</i> sp	-	-	-	-	-	-	+	-	-	17	
<i>Cladophora oligoclona</i> Kutz	+	+	+	+	+	-	+	-	-	54	
<i>Closterium acerosum</i> (Schrank) Ehr Ex Ralf	-	-	+	+	+	+	+	-	-	42	
<i>Closterium diane</i> Ehr.var <i>arcuatum</i> (Breb.) Raben	-	+	-	-	-	-	+	-	-	17	
<i>Closterium tumidum</i> var <i>nylandicum</i> Gronbl	-	-	-	+	-	-	-	-	-	4	
<i>Cosmarium askenasiyi</i> Schmidle Scot and Prescott	-	-	-	-	+	-	+	-	-	17	
<i>Cosmarium decoratum</i> West and West	+	+	-	-	-	-	-	-	-	29	
<i>Cosmarium monodii</i> Bourrelly	+	+	-	-	-	-	-	-	-	21	
<i>Cosmarium quadrum</i> lund.	-	-	+	-	-	-	-	-	-	4	
<i>Desmidium coarctatum</i> Nordst.	+	+	-	-	-	-	-	-	-	21	
<i>Desmidium swartzii</i> Agard	+	+	-	-	-	-	-	-	-	21	
<i>Desmogonium rabenhorstoanum</i> var <i>elongatum</i> Patr.	+	+	-	-	-	-	-	-	-	25	
<i>Euastrum pseudopectinatum</i> Schmidle	+	-	-	-	-	-	-	-	-	8	
<i>Eudorina elegans</i> Ehr.	-	+	-	-	-	-	-	-	-	8	
<i>Hyalotheca dissiliens</i> (Smith) Breb	-	-	+	-	+	-	+	-	-	13	
<i>Micrasterias doveri</i> (Biswas) var <i>africana</i> Bourrelly	-	-	-	+	-	-	-	-	-	8	
<i>Micrasterias fimbriata</i> Ralfs	-	-	+	-	-	+	-	-	-	13	
<i>Micrasterias foliaceae</i> Bailey	-	-	+	-	-	-	+	-	-	21	
<i>Micrasterias thomasi</i> (Nordst) Gronbl	-	+	-	-	-	-	-	-	-	4	
<i>Micrasterias torreyi</i> Bail	-	+	-	-	-	-	-	-	-	13	
<i>Mougetia sphaerocarpa</i> Wolle	+	+	-	+	-	-	-	-	-	25	
<i>Mougeotia</i> sp	+	+	-	-	-	-	-	-	-	13	
<i>Oedogonium grande</i> Kutz	-	-	-	-	-	-	-	-	-	8	
<i>Oedogonium suecicum</i> Wittr.	+	+	+	-	-	+	-	-	-	29	
<i>Pandorina</i> sp	-	+	-	-	-	-	-	-	-	8	
<i>Pleurotaenium coronulatum</i> (Breb) Rabenh var <i>fluctuatum</i> W. West	-	-	+	-	-	-	-	-	-	8	
<i>Pleurotaenium subcoronnulatum</i> (Turn) West and West var. <i>Africana</i> Sch	-	-	-	-	+	-	-	-	-	8	
<i>Scenedesmus apiculatus</i> var <i>indicus</i> Ehr.	-	+	+	-	-	-	-	-	-	8	
<i>Spirogyra insignis</i> (Hass) Kutz	-	-	-	+	-	-	-	-	-	17	

<i>Spirogyra</i> sp	-	-	-	+	-	+	-	-	25
<i>Spharozosma granulatum</i> Roy and Bliss	+	-	-	+	-	-	-	-	25
<i>Straurastrum setigerum</i> Cleve	-	-	-	+	-	-	-	-	13
<i>Ulothrix tenuissima</i> Kutz	+	+	-	+	-	-	-	-	38
<i>Volvox Africana</i> Ehr.	-	-	-	-	-	-	+	-	8
<i>Zygnema pectinatum</i> (Vauch) C. A. Agardh	-	-	+	-	-	-	-	-	8
DIVISION CYANOPHYTA									
<i>Oscillatoria limnosa</i> Agardh	-	-	-	+	-	-	-	-	8
DIVISION EUGLENOPHYTA									
<i>Euglena acus</i> Ehr.	-	-	-	-	-	-	+	-	4
<i>Euglena oxyuris</i> Schmarida	-	-	-	-	+	+	-	+	17
<i>Eglana</i> sp	+	-	-	-	+	-	-	-	25
<i>Phacus longicauda</i> Duj.	-	+	-	-	+	-	-	-	25
DIVISION RHODOPHYTA									
<i>Batrachospermum vagum</i> (Rothe) C. Agardh var <i>vagum</i>	+	+	+	-	-	-	-	-	21

+ means present - means absent

In general, the overall species diversity of Ikoro Stream is significant, because the continued existence of a wide natural diversity provides protection against both natural and human catastrophes, the predisposition to regeneration and re-colonization of endemic species where such catastrophes may occur (Patrick, 1988). Also, a rich phytoplankton composition helps to sustain and maintain the geochemical cycles operational in such ecosystem. The climate profoundly dictates the phytoplankton dynamics. The transition from the dry season (February-April) to the peak of the rainy season (June-August) introduces distinct changes: The sporadic appearance of rare species (4% occurrence) during specific months implies that seasonal shifts in water temperature, flow velocity, transparency, and nutrient runoff create short, specialized niches. During peak rainfall (June/July), increased water volume and velocity can cause a "dilution effect" or physical flushing, reducing the density of fragile taxa, while resilient diatoms like *Fragillaria* sp. endure the physical stress.

The low occurrence of Cyanophyta (*Anabaena*, *Oscillatoria*) and Euglenophyta (*Euglena*, *Phacus*) is a highly positive indicator of water quality. This could be as a result of low temperature and N/P ratio and also out competition by diatoms and green algae which have faster nutrient uptake rates at low concentrations (Song *et al.* 2026). High populations of cyanobacteria and euglenoids are notorious markers of organic pollution, agricultural runoff, and eutrophication. Because these groups are minimally represented in Ikoro Stream, it can be inferred that the stream is relatively pristine, free from heavy organic pollution, and maintains a stable ecological balance. Furthermore, the presence of the red alga *Batrachospermum vagum* (21% occurrence), which typically thrives in clean, well-oxygenated, flowing streams (Ceschin *et al.*, 2012; Zelazna-Wieczorek and Maminska, 2006), supports this assertion. *Batrachospermum vagum* is one of the few freshwater Rhodophyta algae.

Conclusion: The study identified and classified the phytoplankton flora of Ikoro Stream, revealing a diverse assemblage across five divisions: Bacillariophyta, Chlorophyta, Cyanophyta, Euglenophyta, and Rhodophyta. This varied composition demonstrated the stream's ability to sustain a variety of primary producers. The distribution of phytoplankton varied between sampling stations and seasons, according to spatial and temporal analyses. Although the majority of taxa were widely distributed, certain species showed seasonal or localized appearances due to environmental factors like light penetration, water flow, rainfall, and nutrient availability. Significantly, a number of taxa decreased during the rainy season's peak, indicating that seasonal hydrological variations have a big impact on phytoplankton dynamics. The predominance of Bacillariophyta and Chlorophyta, along with the low abundance of pollution-tolerant Cyanophyta and Euglenophyta, shows that phytoplankton are a good indicator of water quality. These results show that Ikoro Stream has a high oxygen content, a low nutrient enrichment, and little organic pollution. Overall, the phytoplankton community structure shows that Ikoro Stream is in good ecological condition, with stable environmental quality and a high level of biodiversity. These results provide useful baseline data for upcoming biomonitoring initiatives which will contribute to the development of environmental management plans meant to preserve Ikoro Stream's ecological integrity.

DECLARATIONS:

Ethical Approval: This study did not involve human participants or animal experimentation and therefore, did not require formal ethical approval. All procedures involving data handling and analysis was conducted responsibly and in accordance with standard academic and institutional guidelines.

Disclaimer (Artificial Intelligence): The authors hereby declare that no generative Artificial

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Intelligence (AI) technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of this manuscript.

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REFERENCES

- Adeniyi, AO; Akinwale, AO (2017). Phytoplankton composition and physico-chemical parameters of lower river Niger, Agenebode, Edo State. *Int. J Fisheries Aquat. Studies*. 5(3): 256-260
- Akin-Oriola, GA. (2003). On the phytoplankton of Awba reservoir, Ibadan Nigeria. *Revolutionary. Biologia. Tropicana*. 51(1): 99 – 106.
- Arévalo-Moreno, A; Cadena, M; Valencia, K; Tobes, I. (2026). Environmental Patterns of Phytoplankton Community Composition Across Lentic and Lotic Systems in Ecuador. *Water* 18(4), 496. <https://doi.org/10.3390/w18040496>
- Bellinger, EG; Sigee, DC. (2015). *Freshwater algae: identification, enumeration and use as bioindicators*. John Wiley & Sons. <https://doi.org/10.1002/9781118917152>
- Carol, ML; Timothy, RP. (1993). *Biological Oceanography: An Introduction*. 1st Edn., Butterworth Heinemann Ltd., Linacre House. Jordan Hill, Oxford Pp 301.
- Ceschin, S; Bisceglie, S; Ricci, S. (2012). Contribution to the knowledge of red algae (Rhodophyta) of some Rivers in Central Italy. *Cryptogamie, Algologie*, 33(1):61-67 <https://doi.org/10.7872/crya.v33.iss1.2011.061>
- Chindah, AC; Pudo, JK. (1991). A preliminary checklist of algae found in plankton of Bonny River in Niger Delta, Nigeria. *Fragmenta Floristica et Geobotanica*, 36: 117 – 126.
- Dokulil, MT; Teubner, K. (2000). Cyanobacterial Dominance in Lakes. *Hydrobiologia*, 438: 1-12. <https://doi.org/10.1023/A:1004155810302>
- Etisa, D; Kifle, D; Fetahi, T. (2024). Phytoplankton functional dynamics in relation to some physicochemical parameters in Lake Kuriftu (Oromia, Ethiopia). *Algal Res*, 79: 103463. <https://doi.org/10.1093/plankt/24.9.901>
- Idowu, RT; Abdulhakim, AF; Onyemaobi, M; Abbator, A. (2018). Dynamics of Phytoplankton Assemblages in Lake Chad Nigeria. *Elixir Agric*, 121: 51535-51541
- Ismail, AH; Hamid, NAS. (2023). Phytoplankton communities in Pinang River, Malaysia: Exploratory study in the profoundly polluted river. *J. Biol. Studies*, 6(1), 19-36. <https://doi.org/10.62400/jbs.v6i1.7753>
- Kadiri, MO. (1987). Algae and primary productivity studies of the Ikpoba River. Unpublished Ph.D Thesis, University of Benin, Pp.289.
- Kadiri, MO. (2000b). Limnological studies of two contrasting but closely linked springs in Nigeria, West Africa. *Plant Biosyst*, 134(2): 123 – 131. <https://doi.org/10.1080/11263500012331358394>
- Kadiri, MO; Akhere, MA. (2021). Phycology. Medad Print House, Benin City, Nigeria Pp 136.
- Karunya, S; Krishnakumar, G. (2021). Biomonitoring of freshwater lentic habitats using desmids. *Limnol*. 23(1): 3. <https://doi.org/10.1007/s10201-021-00664-0>.
- Kefas, M; idauna, SB; Jibrin, MT; Labaran, MD. (2025). Phytoplankton Abundance, Distribution and Diversity in Upper River Benue, Adamawa State, Nigeria. *J. Aquat. Fisheries*, 9: 104. <https://doi.org/10.24966/aaf-5523/1000104>
- Kilham, P; Hecky, RE. (1988). Nutrient Limitation of phytoplankton in Freshwater phytoplankton. *Limnol. oceanogr*. 33: 796-822. <https://doi.org/10.4319/lo.1988.33.4part2.0796>
- Magner, M. (2022). Desmid Communities and Environmental Conditions of New England Wetlands. Bachelor's Thesis, Assumption University, Worcester, MA, USA.
- Mohammed, SB; Banyigyi, AH; Makpo, JD. (2020). Distribution and Abundance of Phytoplankton

- species in Bodna River in Kwali, Abuja. *Int J. Eng. Appl. Sci. Tech*, 6:128-137. <https://doi.org/10.33564/IJEAST.2020.v05i06.018>.
- Moss, B. (2010). Ecology of freshwater: A view for the twenty-first century 4th Edition. Wiley Blackwell. Pp. 482.
- Mustapha, MK. (2008). Assessment of the water quality of Oyun reservoir, Offa, Nigeria, using selected physico-chemical parameters. *Turkish J. Fish. Aquat. Sci.*, 8: 309-319.
- Opute, FI. (1990). Phytoplankton flora in the Warri/Forcados estuary of Southern Nigeria. *Hydrobiologia* 208: 101-109. <https://doi.org/10.1007/BF00008449>.
- Opute, FI. (1991). A checklist of freshwater, brackish and marine phytoplankton of the Warri/Forcados estuaries of southern Nigeria. *Niger. J. Bot.* 4: 227-254.
- Opute, FI; Kadiri, MO. (2013). Phytoplankton Algae of Nigeria. Volume I: The Desmids. Mi Mindex Publishing Company, Benin City, Nigeria. Pp. 304.
- Pal, R; Choudhury, AK. (2014). An Introduction to Phytoplankton: Diversity and Ecology Springer, India. 167p https://doi.org/10.1007/978-81-322-1838-8_1
- Patrick, R. (1988). Importance of diversity in the functioning and structure of riverine communities. *Limnol. Oceanogr.* 33: 1304–1307 <https://doi.org/10.4319/lo.1988.33.6.1304>.
- Pereira, L. (2025). The Unsung Heroes of Aquatic Ecosystems: The Vital Roles of Plankton. In *The Role of Plankton in Freshwater and Marine Ecology*. Intech Open. <https://doi.org/10.5772/intechopen.1009861>.
- Prescott, GW. (1975). How to know the freshwater algae. C. Brown Company Publishers, Dubuque, Iowa Pp 348.
- Song, T; Wei, F; Xu, L; Xu, X; Mao, Z; Zhou, L. (2026). Habitat heterogeneity shapes the differences in composition and structure of phytoplankton functional groups in typical subtropical regions. *Water Res.* 299:125881. <https://doi.org/10.1016/j.watres.2026.125881>
- Streetskumar, R; Joseph, KJ. (1995). Periphyton colonization in Cochin estuary. *Indian J. Mar. Sci.* 24: 94-96.
- Zelazna-Wiezorek, J; Maminska, M. (2006). Algaeflora and vascular flora of a limestone spring in the Warta River valley. *Acta Societatis Botanicorum Poloniae*, 75(2), 131-143. <https://doi.org/10.5586/asbp.2006.016>
- Zhang, Q; Xi, Z; Li, C; Ye, C; Wang, Y; Ye, Z; Wei, W, Wang, H. (2025). Environmental factors affecting phytoplankton composition in the Lake of Tibetan Plateau. *Diversity* 17(1): 47. <https://doi.org/10.3390/d17010047>