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Taxonomy, Distribution And Diversity Of Phytoplankton In Some Water Bodies In Kaduna Metropolis, Nigeria

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Abstract
Three different river microenvironments were analysed over a period of six months for phytoplankton communities and underlying water parameters. Running water, alluvial based, agriculturally impacted sample station (NDA - Nigerian Defence Academy stream, Afaka), running water, rocky based, domestic activity impacted station (GTC - Government Technical College stream, Malali) and an impounded lake, veterinary impacted station (ABU - school of agriculture, Ahmadu Bello University dam, Mando) in Kaduna were studied with the aim of identifying, classifying and exploring the diversity and distribution of the algal species in the study areas. The result showed that station NDA had the highest value of species richness making up 38.24% (65 species) of overall observed species in the studied areas. Station GTC recorded 43 species making up to 25.29% and Station ABU contained 36.47% of the sample with 62 species. A total of 170 species of phytoplankton in general and seven taxonomic groups were collected. Of this total, the Chlorophyta had the highest number of species (90 species), followed by Bacillariophyta with 46 species and are showed in this order: Chlorophyta > Bacillariophyta > Cyanophyta > Euglenophyta > Rhodophyta > Dinophyta & Chrysophyta. There were remarkable variations of physico – chemical parameters and significant difference in the sampling sites ($p < 0.05$).
Keywords: Phytoplankton, Communities, Aquatic Environments, Kaduna, Nigeria.

1. Introduction

Large and diverse groups of simple, typically autotrophic organisms, ranging from unicellular to multicellular forms are termed ''algae''. They are photosynthetic like plants and simple because their tissues are not organized into the many distinct organs found in land plants. They are widely present in moist terrestrial locations or freshwater environments, such as lakes and rivers, and moist soils, and within host organisms, where they are typically present as micro-organisms visible only with the aid of a microscope (Bellinger *et al*, 2010). Russell *et al* (2008) further explained that the protist groups include various types of algae ranging from heterokonts to archaeplastida. The heterokonts include bacillariophyta (diatoms), chrysophyta (golden algae) and phaeophytas (brown algae) while the archaeplastida include rhodophyta (red algae), chlorophyta (green algae) and the true land plants (viridaeplantae) all of which are eukaryotes. They have a true nucleus, with multiple, linear chromosomes.

Water systems are typically dominated by either *planktonic* (free-floating) algae or *benthic* (substrate-associated) organisms. The density and diversity of phytoplankton are influenced by the quality of water. Diversity indicates the degree of complexity of community structure. It is the function of number of species and abundance diversity has often been related to environmental characteristics of water mass and energy within community (Nath *et al,* 2006).

Some work has been done in the plankton composition in some Nigerian waters. Imovbore (1965) made a preliminary checklist of plankton in Eleiyele reservoir. Adeniyi (1978) identified four main groups of plankton in Lake Kainji; these were myxophyceae, chlorophyceae, bacilliariophyceae and dinophyceae. Nkwoji (2010) studied the spatial occurrence of wet season phytoplankton and zooplankton in Lagos lagoon. Akoma (2007) reported the phytoplankton flora of the Imo River estuary. Kadiri (1993) also reported the seasonal changes in the phytoplankton standing crop of the Ikoba reservoir. Kemdirim ,1990 observed four major groups of phytoplankton in Shendam and Pankshin reservoirs and in another study undertaken in 2001 identified 71 species of algae with Chlorophyceae as the dominant family in Shendam reservoir. Dimowo (2013) reported the phytoplankton species composition and abundance in Ogun River.

Algae are commercially cultivated as nutritional supplements like *Chlorella* and *Dunaliella salina*. The growth of some of these phytoplanktons in water bodies include discoloration, foul odors, unpleasant tastes and clogged filters, thereby escalating the cost and infrastructural requirements for their purification. The present study has carried out checks on the algal species biodiversity of some aquatic environments within kaduna metropolis.

2. Materials and Method

2.1 Description of Study Locality

The research was carried out within areas in Kaduna metropolis, Kaduna State, Nigeria. Kaduna metropolis is

located within the Guinea savannah with coordinate's latitude 10°31′23″N, longitude 7°26′25″E. Three sampling sites were selected within Kaduna metropolis. They are:-

- **Site A** - NDA Stream, Afaka is on agrarian FADAMA used for farming particularly rice. This is because of rice padding; pesticides and herbicides are used as fertilizers. It is a lotic ecosystem with the stream following a meandering course which leads to the slow speed of the stream.
- **Site B** - within Government technical college (GTC), Malali is an urbanized stream serving as run-offs to the major river Kaduna and collector domestic wastes from houses in adjoining communities. It is also a lotic ecosystem.
- **Site C** – ABU , school of Agric dam, Mando is a lake created by impoundment of the flowing stream by earth dam. It is a lentic ecosystem used primarily for irrigation and cattle rearing.

Figure 1 show the map of the sampling sites where the study was carried out.

2.2 Sample Collection and Preservation of Algal Species

Samples for the investigation were collected once a month from November 2012 to April 2013. Phytoplankton was collected using methods described by APHA (1985). The samples were collected between 11am - 1pm. A cone shaped plankton net with diameter of net opening of 20 cm was hauled over 5m at a rowing speed. The net was attached to a collection vial of 50ml where concentrated phytoplankton samples were collected. Two to three drops of Lugol's iodine solution (20g of potassium Iodide + 200ml of distilled water + 10g of pure Iodine crystals + 20ml of glacial acetic acid) was added to the 50ml of the sample to precipitate and preserve the algal species, (standard methods of APHA (1999) as sited by mahadev *et al*, 2011) within 8 hours of collection time. Another water samples from the surface of the water bodies was also collected randomly using 1litre capacity sampling bottles from the stations for 6 months for other analysis in the laboratory.

2.3 Identification of Algal Species

This was done in the hydrobiology/ zoology laboratory of the department of Biological Sciences, Nigerian Defence Academy. The method of Kemdirim (2001) was modified for the recording of presence and frequency of algal organism as follows: one drop from each preserved samples was taken with the help of small pipette and placed on a clean glass slides and covered with cover slips. This was observed under the light microscope and captured with the digital oplenic microscope eyepiece (model 5621). This process was repeated in five fields of view and the phytoplanktons in each view recorded. Presence was marked with a (+) sign and frequency with multiples of as many fields as they are found. The objectives used are 4^X, 10^X, and 100^X eye piece. The specimens were identified with the help of available literatures, standard books and keys (Prescott, 1954; Prescott 1961, Bellinger *et al*, 2010; Algalbase and Algal web).

3. Result

Total number of recorded species were 116 (Table 1) belonging to seven different taxonomic groups namely; Chlorophyta (65), Bacillariophyta (25), Cyanophyta (10), Euglenophyta (8), Rhodophyta (4), Dinophyta (1) & Chrysophyta (1). Highest number of algal species (65) 38.24% was registered at site A, followed by (62) 36.47% and (43) 25.29% at sites C and B respectively within Kaduna metropolis (Fig 2). The abundance of phytoplankton species is presented in Table 2 and Figure 3. Chlorophyta was the most abundant with 53%. This was followed by Bacillariophyta (27%), Cyanophyta (9.4%), Euglenophyta (7.1%), Rhodophyta (2.4%), Dinophyta (0.6%) and Chrysophyta (0.6%).

4. Discussion

The diversity of algal species at the three study sites recorded the total number of 116 algal species belonging to seven different taxonomic groups namely; Chlorophyta, Bacillariophyta, Cyanophyta, Euglenophyta, Rhodophyta, Dinophyta & Chrysophyta which almost corroborate with the findings of Calijuri, 2002 and Chergui *et al*, 2013 in respect to phytoplankton distribution. This finding agrees with that of most authors who reported that the phytoplankton community in fresh water is mostly chlorophyta, cyanophyta, diatoms and dinophyta (Sorayya et al., 2011). Similar studies by Adebisi (1981), Ayodele et al., (1999) showed that blue algae and green algae dominate most tropical African lakes.

The most dominant Chlorophyta (53%) reported in the water bodies was *Closterium sps* and *Cosmarium sps* both from the *Desmidiaceae* family which is consistent with Akoma, 2007. This indicates that the ecosystem is low in nutrients, slightly acidic and dystrotrophic (Bellinger *et al*, 2010). It was followed by the *Chlamydomonaceae* and *Zynemataceae* families out of nineteen families recorded. Other families include; *Chlamydomonadaceae, Ulotrichaceae, Palmellaceae, Characeae, Oocystaceae, Volvocaceae, Mesotaeniaceae, Hydrodictyaceae, Microsporaceae, Tetrasporaceae, Chlorosarcinaceae, Chaetophoraceae, Dictyosphaeriaceae, Scenedesmaceae, Oedogoniceae* and *Ulvaceae.*

Among eight Bacillariophyta (27%) families recorded, the dominant species include *Navicula sps,*

Calonies sps and *Neidium sp* from the family *Naviculaceae* followed by the *Fragilariaceae* family for example *Tetracyclus, Synedra sps*. The dominance of *Naviculaceae* agrees with the work of Olele *et al*., 2008 and Akoma 2007. Other families include *Surirellaceae, Eunotiaceae, Cymbella, Nitzchiceae, Coscinodiscaceae* and *Diadesmidaceae*.

Among Cyanophyta (9.4%), *Chroococcaceae (Microcystis, Coelosphaerium etc)* family was the main representative of the group; others are *Nostocaceae, Oscillatoriceae* and *Chamesiphonaceae*. The abundance of *Cyanophyta* observed in this study must have been caused by the polluted nature of the water due to the anthropogenic activities carried out around its shore. Similar observations were recorded by Dimowo, 2013 and Shakila *et al* (2012)

The Euglenophyta group (7.1%) was recorded to be dominated only by species of the *Euglenaceae* family (Trachelomonas, Euglena etc). Hildenbrandiaceae, Batrachospermaceae, Chantransiceae and Lemanceae are families of the Rhodophyta (2.4%) group recorded.

Other groups of the algal species were found sporadically or of relatively low abundance. The Dinophyta and Chrysophyta each contributing less than one per cent is an attestation of the fact that the environment was conducive for their proliferation. The observed low occurrence of the Dinophyta is corroborated with the study of Polat *et al,*2000 and Kadiri, 2006 while low occurrence of chrysophyta indicates the oligotrophic nature of the water (Bellinger *et al*, 2010).

5. Conclusions

Information provided through this study on the distribution of algae indicates the need to control algae in Kaduna water bodies. This knowledge is useful to groups involved in water utilities; irrigation and drainage districts; industries; private pond owners; fish farmers; aqua culturist. From this result it is observed that the water bodies are rich in plankton with a good measure of abundance and diversity. The phytoplankton abundance showed the following order of abundance in general: Chlorophyta > Bacillariophyta > Cyanophyta > Euglenophyta > Rhodophyta > Dinophyta & Chrysophyta. It is observed that some plankton species are low in abundance at some sampling sites. This may be due to sensitive species disappearing as the water becomes polluted while tolerant ones survive pollution stress. The implementation of relevant laws for the sustainability of the water bodies will be required.

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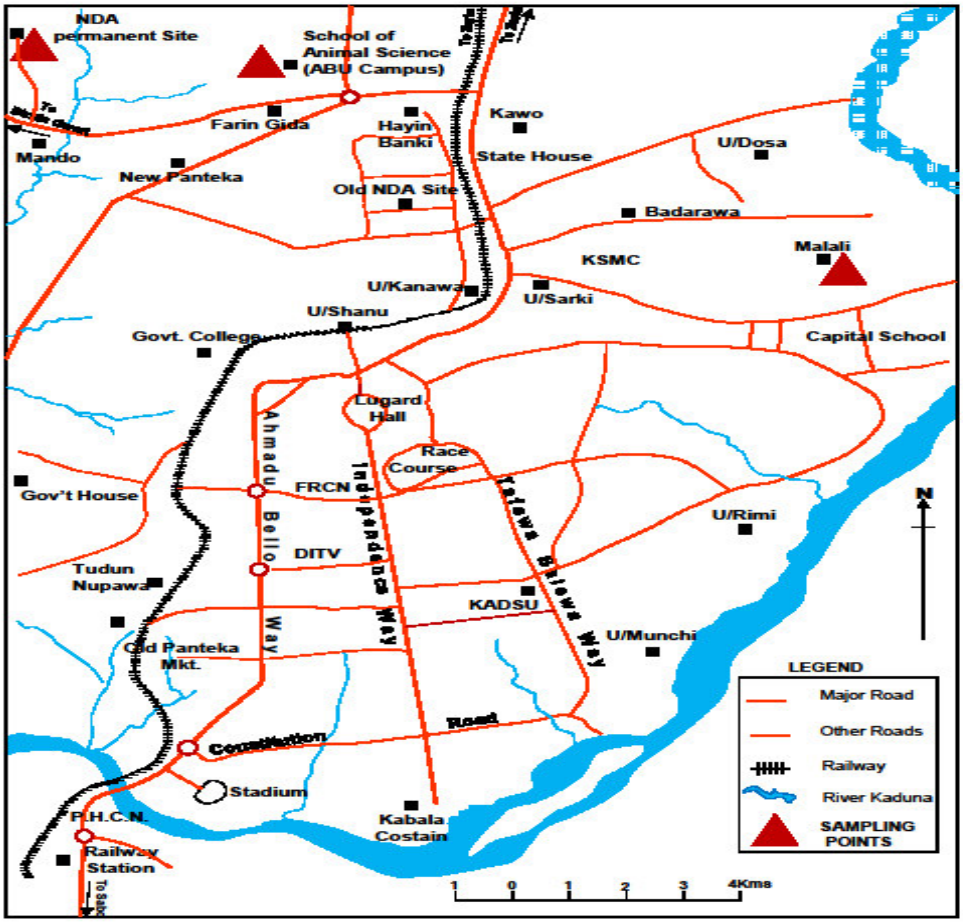

FIG. KADUNA NORTH LOCAL GOVERNMENT AREA SHOWING THE LOCATION OF SAMPLING POINTS
Source: Geo. Dept. NDA Kaduna, 2013.

Phytoplankton Abundance

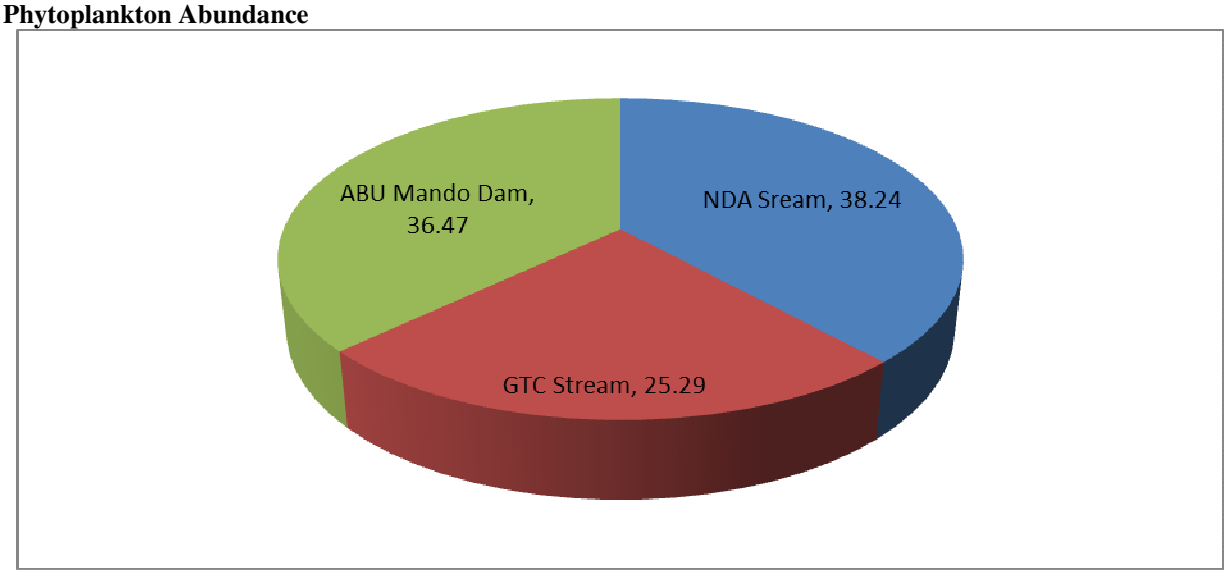

Figure 2: Chart Showing Percentage Phytoplankton Abundance in Sample Sites

Table 1: Species List and Occurrence of Some Algal Species According To Sampled Stations

ALGAL SPECIES	STATIONS		
	A- NDA	B- `GTC	C- DAM
1. Aphanocapsa elachista	-	-	+
2. Anabena flos-aquae	-	+	-
3. Anabena macrospora	-	+	-
4. Ankistrodesmus fusiformis corda ex korshikov	-	+	-
5. Arthrospira skujae.	+	-	-
6. Audouinella	+	-	-
7. Batrachospermum vag	-	+	-
8. Binuclearia tetrana wirtrock	-	+	
9. Bulbochaete congener	-	-	+
10. Caloneis amphisbaena	++	+++	+
11. Ceratoneis arcus	+	-	-
12. Chaetopeltis *orbicularis* Berthold	-	+	-
13. Chamaesiphon incrust	+	-	+
14. Chlamydomonas	-	-	+
15. Chlorosarcinopsis minor Herndon	+	-	-
16. Closterium aciculare	++	+	-
17. Closterium diane	+	-	-
18. Closterium dianae v. minus	+	-	-
19. Closterium gracillimum	+	-	-
20. Closterium idiosporum	+	-	-

21.	Closterium juncidum v. elongatum	+	-	-
22.	Closterium kutzingii	++	-	-
23.	Closterium moniliferum	+	-	-
24.	Closterium parvulum	+++	-	-
25.	Closterium ralfsii	+	-	-
26.	Closterium setaceum	+	-	-
27.	Closterium venus	+	-	-
28.	Coelastrum sphaericum	-	-	+
29.	Coelosphaerium naegelianum	-	-	+
30.	Cosmarium bioculatum	++	-	-
31.	Cosmarium biretum	+	-	+
32.	Cosmarium botrytis	-	-	+
33.	Cosmarium botrytis v. mediolaeve	-	-	++
34.	Cosmarium cyclicum v. arcticum	-	-	+
35.	Cosmarium depressum	-	-	+
36.	Cosmarium impressulum	+	-	-
37.	Cosmarium margaritiferum	-	-	+
38.	Cosmarium moniliform	+	-	-
39.	Cosmarium monomazum	+	-	-
40.	Cosmarium panamense	-	-	+
41.	Cosmarium portianum	-	-	+
42.	Cosmarium quadratum	+	-	-
43.	Cosmarium quadrifarium	-	-	+
44.	Cosmarium reniforme v. compressum	-	-	+
45.	Cosmarium subcostatum	+	-	-
46.	Cosmarium venustum	+	-	-
47.	Cosmocladium	-	-	+
48.	Craticula cuspidata	-	-	+
49.	Cylindricospermum specie	+	-	-
50.	Dactylococcus infusionum Naeg.	-	+	-
51.	Diadesmis	-	+	-

52. Diatoma vulgaris	+	+	+
53. Dictyosphaerium pulchellum wood	-	-	+
54. Encyonema minutum	+	-	+
55. Eudorina	-	-	+++
56. Euglena mutabilis	+	-	-
57. Euglena oxyuris	-	+	+
58. Euglena oxyuris var. minor prescott	+	-	-
59. Euglena proxima	+	-	-
60. Euglena tripteris	-	+	-
61. Euglena viridis	-	+	-
62. Eunotia bilunaris	++	-	-
63. Fragilaria sps	+	-	-
64. Frustulia	+	-	-
65. Geminella interrupta (Turp)	-	+	+
66. Gonatozygon monotaenium	+	-	-
67. Haematococcus lacustris cyst	++	++	++
68. Hildenbrandia	-	+	-
69. Hydrodictyon	-	+	-
70. Lemanea annulata kuetz.	-	-	+
71. Lepocinclis sp	-	-	+
72. Massartia	-	-	+
73. Melosira varians	-	-	+
74. Microspora crassior (Hansg) Hasen.	-	+	-
75. Micospora floccosa	+	-	-
76. Microcystis aerugino	+	-	++++
77. Microcystis flos-aqu	-	-	+
78. Mougeotia genuflexa	+	-	+
79. Navicula contenta	+	-	-
80. Navicula confervacea	+	-	-
81. Navicula cuspidate var. ambigua	+	-	-
82. Navicula digitoradiata fa..	-	-	+
83. Navicula petersenii Hustedt	+	-	-
84. Neidium iridis var. subundulata. Reime	-	+	-
85. Neidium productum	+	-	-
86. Netrium digitus var. naegelii (Brebisson)	+	-	-
87. Nitella batrachosperma (Reich) A. braun	-	++	++
88. Nitzschia radicula	-	+	-
89. Nitzschia vermicularis	+	-	-

90. Oocystis	-	-	+
91. Oscillatoria sp	-	+	+
92. Pediastrum duplex	-	-	+
93. Pseudoulvella americana (snow) Wille	-	+	-
94. Schizomeris leibleinii kuetzing,	-	+	-
95. Sirogonium sticticum Kuetzing	-	+	-
96. Spirogyra acquinoctia G West	-	+	-
97. Spirogyra fluvialitis	-	-	+
98. Spirogyra fuellebornei Schmidle	-	+	-
99. Spirogyra novac-angliac Transeau	-	-	+
100. Spondylosium planur	-	+	-
101. Sphaerocystis schroeteri chodat	-	-	+++
102. Staurastrum ophiura		+	
103. Staurodesmus cuspidatus	-	-	++
104. Staurodesmus triangularis	-	-	+
105. Stauroneis phoenicentron	++	+	-
106. Surrirella capronii.	++	-	++
107. Synechococcus aeroginosus	-	-	+
108. Synedra acus	+	-	-
109. Synedra berolinensis	-	-	+
110. Synedra ulna	+++	+	+
111. Tetracyclus	-	+++	-
112. Tortitaenia	+	-	-
113. Trachelomononas Dybowskii Drezepolski	+	-	++
114. Ulothrix tenerrina	-	+	+
115. Urococcus insignis	-	+	-
116. Vaucheria	-	+	-
Total Count Of Organisms	**65**	**43**	**62**
	170		

Table 2 - Phytoplankton Abundance According To Taxonomic Groups

Taxonomic groups	Abundance	% Abundance
Chlorophyta	90	52.94
Bacillariophyta	46	27.06
Cyanophyta	17	9.4
Euglenophyta	11	7.1
Rhodophyta	4	2.35
Dinophyta	1	0.6
Chrysophyta	1	0.6
Total	170	100

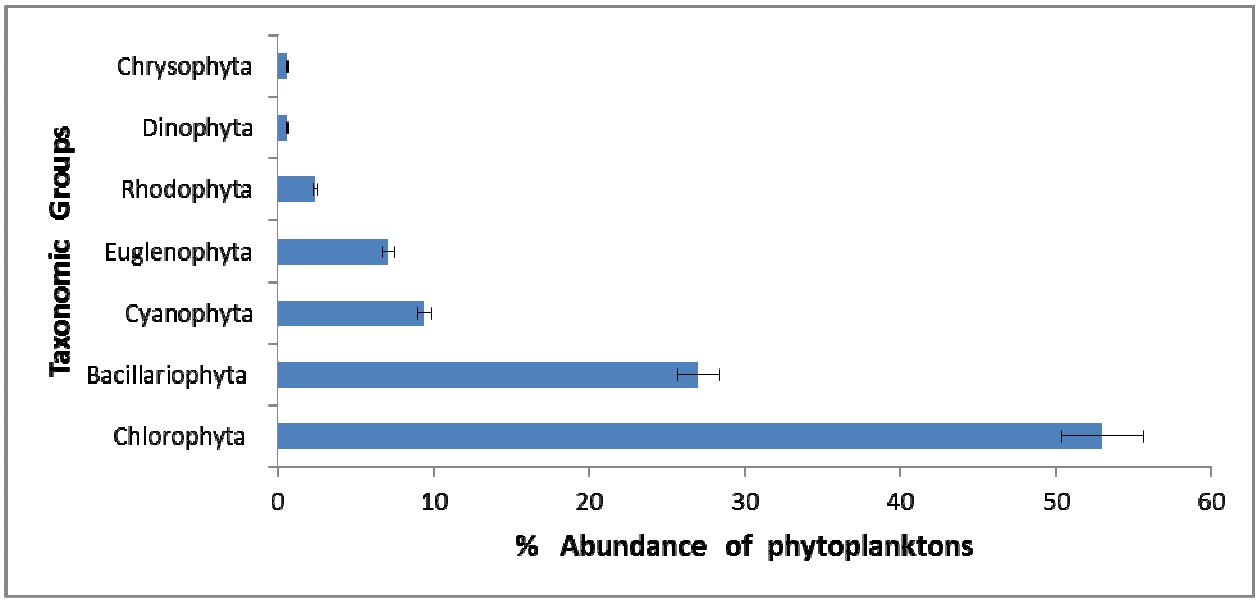

Figure 3: Chart Showing the Percentage Abundance According To Their Taxonomic Groups.

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