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# Water Quality Disturbances on Phytoplankton Species Composition and Abundance in Mini-Ndai Creek, Niger Delta, Nigeria

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***Authors' contributions***

*This study was carried out in collaboration between both authors. The design of the study and the field as well as the laboratory work was carried out jointly by the two authors. While author UF wrote the first draft of the manuscript, author OAFW handled the statistical analysis. Both authors read and approved the final manuscript.*

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## ABSTRACT

An investigation into the effect of water quality disturbances on the phytoplankton species composition and abundance in Mini-Ndai creek was carried out over a 6- month period from March-August 2012. Five sampling stations were established within the creek with station 5 marked as contaminated, surface water and phytoplankton samples were collected monthly and analyzed according to standard methods. Concentrations of physic-chemical parameters were similar to previous reports in the Niger Delta. A total of 66 species of phytoplankton belonging to 32 genera and 3 classes were identified throughout the study. Bacillariophyta (Diatoms) consisting about 97% dominated the phytoplankton community followed by Cyanophyta (2.36%) and Chlorophyta (0.45%). Station 5 which houses the abattoir had the highest concentration of nitrates and pH which showed a significant positive correlation with phytoplankton total abundance which was equally highest at station 5. Anthropogenic input of organic load into the aquatic ecosystem as revealed in

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this study influenced the species composition, distribution and abundance of the phytoplankton community of Mini-Ndai Creek.

*Keywords: Mini- Ndai creek; phytoplankton; Niger Delta; abundance; species composition.*

## 1. INTRODUCTION

The quality and quantity of most aquatic organisms depends on the quality of their environments (water or sediment), especially the physic- chemical variables, qualities and the features of the water and the sediment environment. Some of these organisms include but not limited to microscopic free floating organisms called plankton. Planktons according to [1], are small plants or animals that float, drift or weakly swim in the water column of rivers, ocean, lakes etc. Planktons lack the ability of self-propulsion and are therefore transported by currents through the open water bodies. Planktons of plants origin are called phytoplankton and those of animal origin are called zooplanktons. They form the base of food web in lakes, oceans [2]. Phytoplankton is of great importance in bio-monitoring of pollution [3]. The distributions, abundance, species diversity, species composition of the phytoplankton are used to assess the biological integrity of the water body [4]. Phytoplankton also reflects the nutrient status of the environment. They do not have control over their movements thus they cannot escape pollution in the environment. Man's activities, be it in agriculture, industry, etc releases wastes and other by-products which find their way into the aquatic ecosystem, and alters the quality of the recipient water body. These factors influence the occurrence, abundance and distribution of plankton organisms [5]. Also, their composition and distribution vary from place to place and year due to the dynamic nature of aquatic systems [6]. These characteristics of different species of phytoplankton can sometimes help scientist distinguish one water mass from another [7]. The productivity of aquatic systems including the production of fish which depends on the quality and, or quantity of plankton organisms present may be influenced.

Phytoplankton and its ecological attributes could be used as indicators of changing conditions in aquatic ecosystem [8] with bacillariophyta as dominant phytoplankton flora, followed by the chlorophyta in decreasing order as revealed in Bernam River Malaysia. Algae or phytoplankton bloom in eutrophication can lead to large sediment of organic matter and depletion of oxygen which under critical point creates anoxic condition in the environment. But at moderate concentration of nutrients, fishes like, herring, sprat and cod could be attracted to the coastal areas of organic waste dump [9]. Phytoplanktons are the foundation of the food web, in providing nutritional base for zooplankton and subsequently to other invertebrates, shell fish and finfish [10].

Recently, following the acute shortage of residential accommodation in Port Harcourt, there has been an upsurge in the population of Rumuorlumeni (Iwofe), including industrial concerns. This has led to an increase in the amount of waste (including household wastes, sewage as well as minor industrial wastes) generated daily – which are largely disposed in the Mini- Ndai Creek. These in addition to the abattoir where cows are slaughtered and processed daily may have impacted on the creek and therefore the need for this investigation.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

The study was carried out in Mini- Ndai creek located at the Minikpiti area of Rumuolumeni in Obio/Akpor local Government Area of Rivers State in the Niger Delta of Nigeria for a period of six months (March- August 2012). It is tidal all year round; water enters the creek at high tide from the Iwofe main river and as the ebbs, water drain from the surrounding mangrove swamp into the river via the creek. The vegetation found are notably riparian flora that includes; White mangrove (*Avicennia nitida)*, Red mangrove (*Rhizophora racemosa)*, and ferns (*Acreospalum orbiquilare)*. The creek is very important to the inhabitants because it serves as a means of transportation for human and timber products; recreation such as swimming and fishing. It also serves as refuse and sewage dump site for the locals while industrial effluents such as waste oil from firms in the area are discharged directly into the creek.

Five sampling stations were established, approximately 6-10 meters from the Osimini-

Minikpiti creek banks and 40-60 metres from each other, station 5 which hosts an abattoir was considered impacted.

## 2.2 Sample Collection and Analysis

Surface water and phytoplankton samples were collected between March - August 2012. Surface water samples were analyzed according to standard methods [11] for physico- chemical parameters namely dissolved oxygen(DO), biological oxygen demand(BOD), phosphate, pH, conductivity, salinity, chloride, nitrate and turbidity, temperature and depth were measured in-situ.

Phytoplankton samples were collected by filtering 20 liters of surface water through plankton net of 25 µm mesh size and the net content was washed into a 100 ml plastic container, into which was added few drops of 10% formalin and 2 drops of eosin to preserve the sample and stain the tissues of the organisms respectively. The preserved sample was taken to the laboratory in an ice-chest container where it was allowed to settle for 48 hours, after which the supernatant was decanted to concentrate the sample. The concentrated sample was shaken to make for proper mixing before pipetting 1ml sub-sample with a pipette into sedge- Wick- Rafter counting chamber and viewed under compound microscope [11]. The identification and enumeration was done using the descriptive keys of [12-14].

## 3. RESULTS AND DISCUSSION

The mean values of physic-chemical parameters for the different sampling stations are presented in Table 1. The highest pH value of 6.92±0.15 was recorded in station 5, while the lowest value of 6.12±0.64 was recorded in station 1. The highest value recorded in station 5 could be attributed to high level of animal droppings and soil type found in the station. Temperature value fluctuated from a high of (27±0.81) gotten in station 1 to a low of (26.5±0.57) and (26.5±1.29) gotten in stations 2 and 4 respectively. Variation of temperature in water bodies is attributed to the insulating effect of increased nutrient load resulting from input of industrial discharges [4]. Dissolved oxygen value was highest in station 3 (5.83±2.16 mg/l) and lowest in station 1 (3.61±1.44 mg/l). The maximum chloride level (3159.50±2853.36 mg/l) was recorded in stations 3 and 4 while the lowest level (2644.50±2495.17 mg/l) was observed in station 1. Salinity value was highest in station 4 (6.45±5.92%) but lowest in station 3 (5.62±5.13%). The highest and lowest values of turbidity were gotten in stations 4 (9.27±6.91NTU) and 1 (5.75±4.92NTU) respectively. This might be due to the increase in sediment load from surface runoff in station 4. The concentration of phosphate ($P0_4$) and nitrogen ($N0_3$) were low but that of sulphate ($S0_4$) was relatively high. The high sulphur level resulted from the high domestic and industrial waste being released into the creek from surrounding environment [7].

A total of 66 species of phytoplankton belonging to 32 genera and 3 classes were identified which was dominated by Bacillariophyta (Diatoms). The Phytoplankton families identified were Bacillariophyta (97.18%), Cyanophyta (2.36%) and Chlorophyta (0.45%) in decreasing order of dominance (see Table 2).

Station 1 recorded (720 individuals/ml) of Bacillariophyta, and Cyanophyta (160 individuals/ ml). Stations 2 has Bacillariophyta (5240 individuals / ml), Cyanophyta (520 individuals /ml) and Chlorophyta (80 individuals / ml), Stations 3 has Bacillariophyta (5240 individuals / ml), while station 4 has Bacillariohyta (7600 individuals / ml), Cyanophyta (160 individuals / ml) and Chlorophyta(80 individuals / ml) and station 5 has Bacillariophyta (9200 individuals/ml). Bacillariophyta contributed the highest 862 individuals/ml (97%) and Chlorophyta 4 individuals/ml (0.45%) (Fig. 1).

The 66 species of phytoplankton recorded in this study is low when compared to some other reports in the Niger Delta. [15] recorded 143 species in Elechi creek, [16], recorded 198 species in the Ntawogba creek, while [17], reported 130 species in the lower Bonny river. It is however higher than 43 and 39 species recorded by [18] in the lower Sombreiro River and [19], in the upper Luubara creek both in the Niger Delta. The dominance of the phytoplankton community of Mni-Ndai creek by Bacillariophyta is supported by the earlier report of [15], [18] and that of [17]. It however contrasts with the conclusion of [16], who reported Cyanophyta as the dominant class.

The observed high density of phytoplankton in station 5 could be attributed to the accumulated waste like animal droppings and processing during slaughtering and other domestic waste that could be found in this station. These high organic materials enhance phytoplankton growth that supports zooplankton community. The low density of phytoplankton observed in stations 2 and 3 could be linked to low phosphate and nitrogen. Phytoplankton total abundance correlated negatively with chloride as shown in Table 3. Nitrate and pH values showed a significant positive correlation with phytoplankton abundance, this position is further supported by the conclusion of [20] that nitrates in water cause an increase in algae growth. [21], went further to implicate human and animal wastes as sources of nitrates, which justifies the highest phytoplankton abundance as well as nitrate concentration in station 5. Station 5 had the lowest number of species but the highest in terms of phytoplankton total abundance; this means that only a few species that are favored by the prevailing environmental conditions account for the observed abundance. The study had shown that the distribution, abundance and diversity of phytoplankton in the Mini-Ndai Creek reflect the physical and chemical conditions of aquatic ecosystem in general and its nutrients (nitrates) statue in particular [22,23]. The dominance of Bacillariophyta in terms of abundance indicates pollution [24]. The lower abundance of Cyanophyta and Chlorophyta could be a reflection of their stocks at those stations, given the patchy distribution of phytoplankton in nature [24].

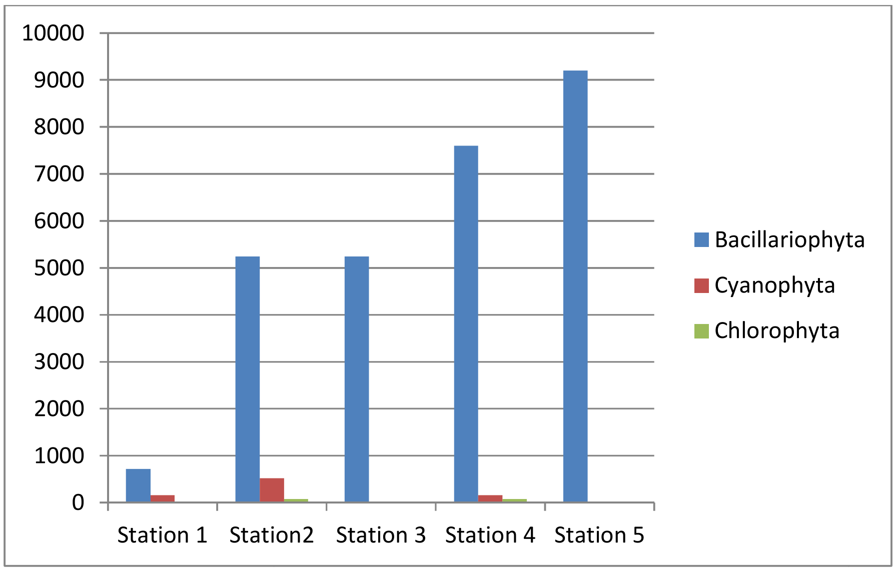


**Fig. 1. Variation in phytoplankton abundance in relation to stations in Mini-Ndai creek**

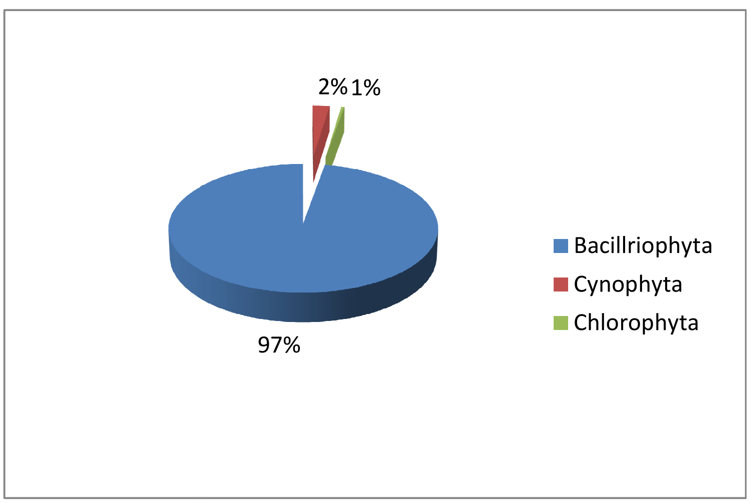


**Fig. 2. Phytoplankton class abundance in Mini-Ndai creek**

**Table 1. Mean values of physico- chemical parameters in surface water of Mini–Ndai creek**

| Station | $P^H$ | Temperature (℃) | Dissolved Oxygen (mg/l) | Biochemical Oxygen demand (mg/l) | Chloride ($Cl^-$) mg/l | Phosphate ($P0_4{}^3$)mg/l | Nitrate ($NO_3$)mg/l | Sulphate($S0_4{}^3$) (mg/l) | Salinity (mg/l) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.12±0.64 | 27.00±0.81 | 3.61±1.44 | 0.92±0.24 | 2644.5±2 495.17 | 0.03±0.01 | 0.03±0.02 | 278.62±276.59 | 5.80±5.54 | 5.75±4.92 |
| 2 | 6.25±0.75 | 26.50±0.57 | 4.63±2.17 | 1.23±0.33 | 3078.0±2 569.25 | 0.08±0.03 | 0.09±0.14 | 211.07±185.88 | 5.82±5.58 | 7.25±5.73 |
| 3 | 6.25±0.55 | 26.75±1.50 | 5.83±2.16 | 1.72±0.74 | 3159.5±2 853.36 | 0.05±0.00 | 0.08±0.08 | 247.35±200.17 | 5.62±5.13 | 8.00±8.366 |
| 4 | 6.17±0.38 | 26.5±1.29 | 3.91±1.31 | 1.42±0.52 | 2938.25±2 661.04 | 0.06±0.02 | 0.22±0.12 | 255.65±232.92 | 6.45±5.92 | 9.27±6.91 |
| 5 | 6.92±0.15 | 26.75±1.70 | 5.66±1.74 | 2.02±1.37 | 2678.75± 2440.09 | 0.08±0.04 | 0.31±0.30 | 173.6±141.79 | 5.65±4.87 | 8.75±4.34 |

**Table 2. Phytoplankton composition and abundance in Mini- Ndai creek**

| **Taxa** | **Bacillariophyta** | **Org/ml** | **%** |
|---|---|---|---|
| **S/No** | | **862** | **97.18%** |
| 1 | *Gyrosyma attenuatum* | 5 | 0.56 |
| 2 | *G. acuminatum* | 6 | 0.67 |
| 3 | *Surirella spp* | 6 | 0.67 |
| 4 | *S. cistula* | 7 | 0.78 |
| 5 | *Nitzhchia spp* | 6 | 0.67 |
| 6 | *N. palea* | 66 | 7.44 |
| 7 | *N. longissima* | 14 | 1.57 |
| 8 | *N. paleacea* | 86 | 9.69 |
| 9 | *N. linearis* | 62 | 6.98 |
| 10 | *N. paradoxa* | 5 | 0.56 |
| 11 | *N. vermicuiaris* | 60 | 6.76 |
| 12 | *N. sigma* | 32 | 3.60 |
| 13 | *N. aniphibia* | 3 | 0.33 |
| 14 | *N. sigmaoides* | 23 | 2.59 |
| 15 | *N. acicularis* | 7 | 0.78 |
| 16 | *N. dissipart* | 21 | 2.36 |
| 17 | *N. cummunis* | 11 | 1.26 |
| 18 | *N. filiformis* | 5 | 0.56 |
| 19 | *N. kutzingiana* | 5 | 0.56 |
| 20 | *N. closterium* | 10 | 1.12 |
| 21 | *N. holsatical* | 35 | 3.94 |
| 22 | *N. horiganica* | 6 | 0.67 |

| **Taxa** | **Bacillariophyta** | **Org/ml** | **%** |
|---|---|---|---|
| **S/No** | | **862** | **97.18%** |
| 23 | *Aniphora spp* | 1 | 0.11 |
| 24 | *A. ovalis* | 3 | 0.33 |
| 25 | *Cyclotella spp* | 7 | 0.78 |
| 26 | *C. Meneghiniana* | 3 | 0.33 |
| 27 | *C. Comta* | 20 | 2.25 |
| 28 | *C. antique* | 6 | 0.67 |
| 29 | *Cosnodiscus spp* | 11 | 1.24 |
| 30 | *C. lacustris* | 25 | 2.81 |
| 31 | *P. augulation* | 4 | 0.45 |
| 32 | *P. elongatun* | 4 | 0.45 |
| 33 | *Bacillaria paradoxa* | 4 | 0.45 |
| 34 | *Pinnularia miscrustaurun* | 9 | 1.01 |
| 35 | *P. maior* | 13 | 1.46 |
| 36 | *P. masolepta* | 3 | 0.33 |
| 37 | *G. augustatum* | 3 | 0.33 |
| 38 | *G. olivaceum* | 4 | 0.45 |
| 39 | *Actinathes spp* | 22 | 2.48 |
| 40 | *Synedra spp* | 13 | 1.46 |
| 41 | *S. nana* | 26 | 2.93 |
| 42 | *S. teneta* | 4 | 0.45 |
| 43 | *S. ulna* | 27 | 3.04 |
| 44 | *Melosira italica* | 5 | 0.56 |
| 45 | *Rhizosolana longiseta* | 5 | 0.56 |
| 46 | *E. tenella* | 6 | 0.67 |
| 47 | *Diploneis spp* | 3 | 0.33 |
| 48 | *Cocconeis plantula* | 26 | 2.93 |
| 49 | *Straurouneis spp* | 45 | 5.07 |
| 50 | *S. anceps* | 21 | 2.36 |
| 51 | *Cylindrotheca gracillis* | 3 | 0.33 |
| 52 | *Navicula. vulpine* | 3 | 0.33 |
| 53 | *N. plicata* | 14 | 1.57 |
| 54 | *N. gyptocephala* | 7 | 0.78 |
| 55 | *Caloneis spp* | 3 | 0.33 |
| 56 | *C. alpestris* | 8 | 0.90 |
| 57 | *Fragilaria spp* | 10 | 1.12 |

| **Taxa** | **Bacillariophyta** | **Org/ml** | **%** |
|---|---|---|---|
| **S/No** | | **862** | **97.18%** |
| 58 | *F. inestinedia* | 6 | 0.67 |
| 59 | *Rhoicosphenia curvata* | 4 | 0.45 |
| | *CYANOPHYTA* | 21 | 2.36% |
| 1 | *Oscillatoria* | 3 | 0.33 |
| 2 | *O. brevis* | 7 | 0.78 |
| 3 | *Phormidium foveolarum* | 5 | 0.56 |
| 4 | *Lymgbia spp* | 1 | 0.11 |
| 5 | *Spirulina princeps* | 2 | 0.22 |
| 6 | *S. major* | 3 | 0.33 |
| | *CHLOROPHYTA* | 4 | 0.45% |
| 1 | *Tetraedrum* | 4 | 0.45 |
| | | 862 | 100 |

**Table 3. Correlation coefficient showing the relationship between physico-chemical parameters and phytoplankton abundance**

| **Correlation** | **pH** | **Temp** | **DO** | **BOD** | **Phospate** | **Nitrate** | **Sulphate** | **Salinity** | **Turbidity** | **Chloride** | **Phyto** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 1 | | | | | | | | | | |
| Temp | 0.038 | 1.000 | | | | | | | | | |
| DO | *0.636 | -0.060 | 1.000 | | | | | | | | |
| BOD | *0.801 | -0.188 | *0.859 | 1.000 | | | | | | | |
| Phospate | *0.622 | *-0.704 | 0.461 | 0.558 | 1.000 | | | | | | |
| Nitrate | *0.786 | -0.347 | 0.335 | *0.748 | *0.643 | 1.000 | | | | | |
| Sulphate | *-0.881 | 0.327 | *-0.647 | *-0.711 | *-0.897 | *-0.686 | 1.000 | | | | |
| Salinity | -0.416 | -0.534 | *-0.646 | -0.282 | -0.028 | 0.220 | 0.369 | 1.000 | | | |
| Turbidity | 0.433 | *-0.643 | 0.407 | *0.748 | *0.577 | *0.816 | -0.447 | 0.411 | 1.000 | | |
| Chloride | -0.388 | *-0.609 | 0.341 | 0.099 | 0.214 | -0.289 | 0.057 | 0.048 | 0.253 | 1.000 | |
| Phytoplan | *0.634 | 0.161 | -0.118 | 0.322 | 0.185 | *0.773 | -0.350 | 0.220 | 0.344 | *-0.818 | 1 |

*Significant values at P < 0.05 are indicated with asterix (*)*

The difference in the nutrients levels is contrary to the reports of [17] in Bonny estuary. [17] reported that nutrients released into most tropical waters (either from the sediment and or contagious ground water sources) are used up by organisms such that the dissolved nutrient water column pool is consistently small [6].

## 4. CONCLUSION

Generally, nutrients, temperature and other physic chemical parameters complement one another in determining the species diversity, abundance and community assemblage of aquatic flora and fauna. However, anthropogenic input of organic load into the aquatic ecosystem as revealed by this investigation in Mini – Ndai Creek, determines or influences the species composition, distribution and abundance of the phytoplankton community.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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