

## Effects of Water Pollution on Phytoplankton Species Composition in Koluama Area, Niger Delta Area, Nigeria

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**Abstract:** The effects of water pollution on phytoplankton species composition in Koluama Area of Niger Delta in Nigeria was studied to create awareness of the consequences of water pollution. Four (4) major families of phytoplankton were recorded; namely Baccillariophyceae, Dinophyceae, Chlorophyceae and Cyanophyceae. Baccillariophyceae were the dominant family and constituted 60% of the total number of phytoplankton. The Baccillariophyceae were represented by 67 species with numerical contribution ranging from 0.21% (*Thalassiothrix nitzschoides*) to 1.73% (*Amphora ovalis*). Cyanophyceae contributed 26% of the total number of phytoplankton count. Twenty-five (25) species were represented in this family and these include: *Oscillatoria formosa* (1.77%), *Phormidium tenue* (1.72%), *Oscillatoria bonnemaisonii* (1.41%) and *Synchococcus aquatilis* (1.38%). Other members of this family include: *Oscillatoria terebriformis* (1.35%), *Merismopedia elegans* (1.22%) and *Phormidium brevis* (1.21%). Chlorophyceae, which contributed 10%, of the total number of phytoplankton were represented by 12 species. The list of some Chlorophyceae species and their relative abundance were *Pleudorina* sp., (1.79%), *Closterium lineatum* (1.25%) and *Phacolus* (1.08%). In all the dominance pattern of the various families of phytoplankton was, Baccillariophyceae>Cyanophyceae>Chlorophyceae>Dinophyceae. The number of phytoplankton in the various stations ranged from  $2800 \times 10^3$  organisms per liter (SW/SD 4) of brackish water in to  $3300 \times 10^3$  organisms/L of water in SW/SD C1. The number of species of phytoplankton ranged between 85 (SW/SD 4 and SW/SD C 2) and 92 (SW/SD C1). This difference may result from the changing status of the environment over time. The sampling keys are: SW/SD 1 (Foropa) SW/SD2 (Ekeni) SW/SD3 (Ejetu) SW/SD4 (Kulama 1) SD/SW 5 (Kulama2) C1(Fish town) and C2 (Ikebiri fishing port 1 and 2). The co-efficient of co-relation (R) was 0.48 ( $R^2 = 0.234$ ), an indication that both variables were poorly correlated.

**Keywords:** Effects, Koluama area, Niger Delta, Nigeria, phytoplankton species composition, water pollution

### INTRODUCTION

Phytoplanktons are plants (microscopic), drifting at the mercy of water current (Anene, 2003). They constitute the primary producers of aquatic ecosystems. They convert incident radiant energy of the sun to chemical energy in the presence of nutrients like phosphorous, nitrogen, iron, manganese, molybdenum and zinc. They are restricted to the aphetic zone where there is enough light for photosynthesis. The distribution, abundance and diversity reflect the physico-chemical conditions of aquatic ecosystem in general and its nutrient statue in particular, (Anene, 2003).

In the aquatic ecosystem, the phytoplankton is the foundation of the food web, in providing a nutritional base for zooplankton and subsequently to other

invertebrates, shell fish and finfish (Emmanuel and Onyema, 2007). The productivity of any water body is determined by the amount of plankton it contains as they are the major primary and secondary producers (Davies *et al.*, 2009). Townsend *et al.* (2000) reported that plankton communities serve as bases for food chain that supports the commercial fisheries. Davies *et al.* (2009) have also reported that phytoplankton communities are major producers of organic carbon in large rivers, a food source for planktonic consumers and may represent the primary oxygen source in low-gradient Rivers.

Phytoplanktons are of great importance in bio-monitoring of pollution (Davies *et al.*, 2009). The distributions, abundance, species diversity, species composition of the phytoplankton are used to assess the biological integrity of the water body (Townsend *et al.*,

2000). 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. Barnes (1980) reported that pollution affects the distribution, standing crop and chlorophyll concentration of phytoplankton.

The study area is one of the numerous water bodies in the Niger Delta of Nigeria providing nursery and breeding grounds for a variety of fish species and other aquatic fauna. The large wetlands and coastal waters of Nigeria, in particular the Niger Delta have great potentials for commercially important fishery (Powell *et al.*, 1985). The Niger Delta is the richest part of Nigeria in terms of natural resources with large deposits of petroleum products (Moffat and Linden, 1995; Braide *et al.*, 2004).

Similarly, the vast coastal features which include forest swamps, mangrove, marsh, beach ridges, rivers, streams and creeks serve as natural habitats for various species of flora and fauna (Alaibo, 1988; Jamabo, 2008). The study area is one of the most important river systems in the Niger Delta providing nursery and breeding grounds for a large variety of fish species (Ezekiel *et al.*, 2002).

The daily life of the people of Koluama in Bayelsa State reflects the daily existence of most people along the creeks and rivers in the Niger Delta. It is a life of extreme struggle, with both the vagaries of nature and man-made obstacles. Most times, communities are far removed from another, connected only by the waters that flow along the extensive creeks into the Atlantic Ocean. Since there are no roads, those who live there and want to reach out to their neighbors, go to market or go fishing, must necessarily move on water, by means of slow-moving dug-out canoes, while some of the more illustrious citizens are able to make use of posh speed-boats for their daily endeavours. Koluama 1 and 2 are part of the eight communities in the State affected by the blowout of gas facility owned by Chevron in January, this year, the others being Ezetu I, Ezetu II, Furoupa, Fish Town, Sangana and Ekeni, with a combined population of about 30,000 people. Access to the communities from Yenagoa, the state capital, takes two and half hours ride by speedboat through the creeks. For other boats, the time can be much longer. The journey can be particularly frightening, especially for non-natives not used to water. For the indigenes, there is nothing to worry about as far as riding the waves is concerned. Life in the waters is normal for them. It is a way of life that they were born into.

In the beginning, in spite of the distances they had to cover in the waters, there was peace, harmony and understanding with nature. But things have been drastically altered, especially with the activities of the

oil prospecting companies and their manner of operation in the area. They make good money but are hardly interested in giving back to the communities. It is now common to find oil floating on the creeks, not necessarily from the activities of the oil majors but from the enterprise of Niger Delta indigenes who have established local petroleum refineries along the banks of the rivers and creeks. The base of the mangrove forest bordering the creeks is colored by moulds of oil which will require an unprecedented effort to restore to their natural state. The people burst oil pipelines buried by the oil majors and cause spills in an attempt to siphon the crude for illegal bunkering activities and refine some to dispose of at the readily available markets. The business is risky but who cares? How can oil pipelines pass through their houses and they do not benefit from their content? That is what they seem to think.

Many people do not see how the risky bunkering and illegal petroleum refining and, consequently, the degradation on the creeks, can be stopped in the Niger Delta because of the number of people involved on the one hand and the perceived complicity of the Joint Task Force (JTF) stationed in the area on the other. Apart from the inadequate knowledge of the creeks where the business thrives, the JTF operatives are said to be more interested in extorting money from those in the bunkering and illegal petroleum refining than checking their economic sabotage. Therefore, all along the route to Koluama, thick smoke rises at various positions on the river banks, indicative of the existence of local refineries where business is booming.

Koluama community gained added prominence on the January 16 this year when the Chevron gas facility at its Atlantic Ocean backward exploded, shaking the very foundation of the structures in the community (Plate 1). The blowout released harmful gas into the



Plate 1: Chevron gas rig explosion in Koluama communities in the early hours of Monday January 16, 2012, (Daily Time Nigeria, 2012)

atmosphere and caused a huge conflagration that burnt in the sea, with concomitant disaster to the aquatic life. The cries of the people for remedy to their plight attracted President Goodluck Ebele Jonathan who, last Monday, personally undertook an aerial inspection of the affected gas platform in the sea and later met with members of the communities.

A spokesman of the eight communities affected, Hon. Nimibofa Ayawei, painted a gloomy picture of the disaster to the president, narrating how the incident occurred and how the inhabitants of the area had been neglected by Chevron, the owner of the facility and government. According to him, in the early hours of Monday January 16, 2012, the residents heard a loud explosion from the K.S. Endeavour (Panama) Rig where Fode Drilling Limited, a company contracted by Chevron Nigeria Limited was drilling gas at the North Apoi Field, west of Funiwa Field, Koluama Clan about 5 nautical miles from the Koluama communities in Southern Ijaw Local Government Area of Bayelsa State. The explosion resulted into a huge gas fire and a massive spill.

The huge flame in the sea which was visible could be sighted from the Koluama River burning uncontrollably and emitting dangerous gases and other toxic chemicals into the environment. The Koluama River directly empties into the Atlantic Ocean and as such, the polluted water is carried into the Koluama Rivers and Creeks and other neighbouring communities in the coast line. Ayawei told the President that the massive explosions shook the foundations of houses in Koluama 1, Koluama 2, Kalaweima, Opuama, Tamazo, Kiriseighegbene, Abiakwei and Lobia, among other communities in the Koluama Clan, saying that “we are worried about this development because it was explosions in the course of seismic activities by Shell D’Archy while exploring for oil and gas in the same area that led to the wiping away of ancient Koluama in 1953.”

He emphasized that with this incident, the air space and the ocean had been seriously polluted and the current was carrying the dangerous gases and chemicals into the rivers and creeks of the communities within the coastal areas where the incident occurred. The aquatic or marine life has been adversely affected and dead fishes could be seen floating on the water in the ocean, shore, creeks and rivers of the coastal communities in the area. Dark colored pollutants have been seen spreading on the surface of the ocean from the first day and have been impacting seriously on the people and the coastal shoreline. The health implications of this are no doubt overwhelming, he remarked, as the gases released into the environment such as carbon monoxide, sulphur dioxide, etc., most of which are acidic gases,

have wide-ranging implications on the populace. The former lawmaker spoke of incidents of various forms of ailments including vomiting, stomach pains, difficulty in breathing, acute asthma, etc., resulting in a couple of deaths which had been reported, stating that people had been moving out of the communities for the fear of the unknown.

In spite of the dangers associated with the situation, no assistance has so far gone to the people. That is why, he said, they were very angry with Chevron which they believed had demonstrated stark insensitivity to their plight. “We therefore feel insulted by the claim of Chevron that the gases emitted from the blowout which burnt were not harmful to human and the environment. We really feel insulted by this claim because if these gases were not harmful, Chevron could not have immediately evacuated its personnel from its oil facilities around the scene of the accident. The above claim was not only inciting but was aimed at preventing the victims of this unfortunate incident from taking drastic actions against the company,” the community spokesman added.

They have now put up a list of demand before the President, including shore protection and embankment, reclamation and sand filling of land, canalization, provision of functional health facilities, implementation of the Bayelsa Central Senatorial road/coastal Ring road, provision of concrete walk ways, provision of potable water, quality education for their people and employment, especially with the multinational oil companies operating in their areas. The Managing Director of Chevron, Mr. Andrew Fawthrop, who was present at the occasion, appeared to be loss for words following the bashing he received from the community and managed to say that the blow-out was dying out down to about 3,000 ft and progressing to put the fire out. While appreciating the community as well as staff of Chevron, he spoke of what seemed to the community like a token effort to provide medical assistance, saying that “there will be some community work going on with medical works starting from Wednesday to improve the quality of life.”

The Group Managing Director (GMD) of the Nigerian National Petroleum Corporation (NNPC), Mr. Austen Oniwon, remarked that the rig that exploded was one dedicated to gas, adding that though the incident happened, the Corporation would not be discouraged. “It was an accident. We believe that we have learnt a lot of lessons from it. Immediately it happened, we tried everything possible to control and contain it,” he said. Oniwon revealed that there were 154 people on the rig when the incident occurred out of which two, a Frenchman and an Indian lost their lives and their corpses never found. He explained that

“because it is a blow-out, it is very difficult to quench the fire, but what we are doing now is to drill another well to try and reach the hole and then block it.” Oniwon acknowledged that the communities had been “very magnanimous and very patient with us”, saying, “in spite of all the devastation the oil spill would have caused them, they have not taken to the streets to demonstrate.”

In his remark, the governor of the state, Seriake Dickson, noted that while the people do not have any problem with the exploitation of oil to sustain the national economy, they however want the oil companies to respect the fragile environment of the area as he observed that what happened in these communities was a common occurrence which the people of the Niger Delta had been contending with. “Mr. President, as we all know, what has happened in Koluama is a very familiar event; it is the same story in the Niger Delta, the same story of sacrifice, the same story of inconveniences, the same story of living with risks day by day to be able to produce the mainstay of the economy of our great country.

What has happened in Koulama is the same story in all our communities, countless communities, villages and settlements in Bayelsa State, the Ijaw nation and across the Niger Delta. We have no problem producing what has become the mainstay of our economy but the least we can ask from Mr. President is respect for our environment, protection of our very fragile ecosystem,” he declared. Dickson was however furious with the people who burst oil pipelines for the sake of bunkering and illegal refining, stating that his government had set up a task force to try to fight the ugly situation. After listening to the people, President Jonathan promised the provision of relief materials and compensation to those affected, assuring the people of government's commitment to tackling environmental management issues, not only in the Niger Delta but also in the extreme north of the country where he observed there was desert encroachment. Jonathan added that the federal government would collaborate with Bayelsa State government and Chevron to provide relief materials for the people and noted: “In terms of other demands that have been documented, I noticed that many issues have been raised and these are issues we are quite conversant with. I can assure you that we will look into it, the company, the state government and the federal government will continue to address them.”

The President told the people that “communities impacted must have some relief, some compensation. That is obvious but the quantum will depend on studies that have been carried out by the company and the federal government,” adding that “on my own part, I will reassure you that the federal government is totally committed to the issues bordering on environmental

management, from the Niger Delta to extreme north where we have desert encroachment.” Besides what Chevron and other government agencies would do, he assured that the federal government through the National Emergency Management Agency (NEMA) would provide some of the relief materials sought by the communities. A study of the effects of water pollution on phytoplankton species composition in Koluama area, Niger Delta Area, Nigeria, is aimed at establishing the effect of water pollution on phytoplankton species composition.

## MATERIALS AND METHODS

The effects of water pollution on phytoplankton species composition in Koluama area, Niger Delta Area, Nigeria were studied from April to May 2012 to establish its effects on the environment. A total of seven sampling stations were established: Foroupa (N4 36.004 E5 39.128); Ekeni (N4 41.659 E5 34.451); Ezetu 2 (N4 43.333 E5 34.640); Kuluama 1 (N4 28 433 E5 46.248); Kuluama 2 (N4 25.805 E5 49.582); Fish Town (N4 4.642 E5 51.128) and Ikebiri fishing port (N4 30.374 E5 50.298). Replicate samples were collected and the mean used for further analysis. In each of the sampling stations Plankton samples were collected. Plankton was collected by filtration technique. Twenty five  $\mu\text{m}$  mesh size plankton net was towed from a dugout boat at about  $5\text{-}105^{-1}$  for about a minute. The net content was washed out into a wide mouth plastic container and preserved in 10% formalin solution after proper labelling. This was stored in a cool box and taken to the Laboratory (APHA *et al.*, 1998)

The samples were allowed to stand for at least 24 h in the laboratory for the Phytoplankton to settle before the supernatant pipetted to concentrate the samples. The concentrated sample was agitated to homogenize before pipetting 1 mL sub sample with sample pipette (*ibid*). The content was placed in sedge Wick-Rafter plankton-counting chamber and examined with Leltz-Wetzlar binocular microscope at a magnification of 200x (APHA *et al.*, 1998). The plankton was identified and total number per species recorded using keys and checklists of Hutchinson (1967). Enumeration of plankton was done on natural unit count and reported as units or organisms per milliliter (mL) (APHA *et al.*, 1998). The sampling keys are: SW/SD 1 (Foroupa) SW/SD2 (Ekeni) SW/SD3 (Ejetu) SW/SD4 (Kulama 1) SD/SW 5 (Kuluama2) C1 (Fish town) and C2 (Ikebiri fishing port 1 and 2).

## RESULTS

Table 1 represents each of the major families of phytoplankton in the study area. Four (4) major families of phytoplankton were recorded; namely Baccillariophyceae, Dinophyceae, Chlorophyceae and

Table 1: Relative abundance of major phytoplankton families in the study area

Major phytoplankton families	Relative abundance (%)
Baccilariophyceae	60
Cyanophyceae	26
Chlorophyceae	10
Dinophyceae	4

Table 2: Spatial variation in total phytoplankton counts and number of species in the study area

Sampling stations	No. of species of phytoplankton	Total (No. of Org/L) × 1000
SW/SD 1	86	2900 × 10 <sup>3</sup>
SW/SD 2	89	3100 × 10 <sup>3</sup>
SW/SD 3	91	3200 × 10 <sup>3</sup>
SW/SD 4	85	2800 × 10 <sup>3</sup>
SW/SD 5	89	3050 × 10 <sup>3</sup>
SW/SD C1	92	3300 × 10 <sup>3</sup>
SW/SD C 2	85	2800 × 10 <sup>3</sup>

Cyanophyceae. Baccilariophyceae were the dominant family and constituted 60% of the total number of phytoplankton. The Baccilariophyceae were represented by 67 species with numerical contribution ranging from 0.21% (*Thalassiothrix nitzschoides*) to 1.73% (*Amphora ovalis*). Cyanophyceae contributed 26% of the total number of phytoplankton count. Twenty-five (25) species were represented in this family and these include: *Oscillatoria formosa* (1.77%), *Phormedium tenue* (1.72%), *Oscillatoria bonnemaisonii* (1.41%) and *Synchococcus aquatilis* (1.38%). Other members of this family include: *Oscillatoria terebriformis* (1.35%), *Merismopedia elegans* (1.22%) and *Phormedium brevis* (1.21%). Chlorophyceae, which contributed 10%, of the total number of phytoplankton were represented by 12 species. The list of some Chlorophyceae species and their relative abundance were *Pleudorina* sp., (1.79%), *Closterium lineatum* (1.25%) and *Phacolus* (1.08%). In all the dominance pattern of the various families of phytoplankton was, Baccilariophyceae > Cyanophyceae > Chlorophyceae > Dinophyceae.

The variation in total count of phytoplankton and the number of species in each of the sampled stations is presented in Table 2. The number of phytoplankton in the various stations ranged from 2800 × 10<sup>3</sup> organisms per liter (SW/SD 4) of brackish water in to 3300 × 10<sup>3</sup> organisms per liter of water in SW/SD C1. The number of species of phytoplankton ranged between 85 (SW/SD 4 and SW/SD C 2) and 92 (SW/SD C1). This difference may result from the changing status of the environment over time.

The sampling keys are: SW/SD 1 (Foropa) SW/SD2 (Ekeni) SW/SD3 (Ejetu) SW/SD4 (Kulama 1) SD/SW 5 (Kulama2) C1 (Fish town) and C2 (Ikebiri fishing port 1 and 2). The co-efficient of co-relation (R) was 0.48 (R<sup>2</sup> = 0.234), an indication that both variables were poorly correlated.

## DISCUSSION

The result of this study, however, varies considerably from some other studies in Nigeria. Ogamba *et al.* (2004) reported 143 species in Elechi creek. Davies *et al.* (2009) recorded 169 species in Elechi Creek and Emmanuel and Onyema (2007) reported 82 species in Lagos Lagoon. Phytoplankton abundance is influenced by water temperature, velocity of current, availability of nutrient and light penetration into the water. Abowei *et al.* (2008) attributed influence of lotic environment to the difference of total number of species recorded in Nun River.

The dominance of Bacillariophyceae in this study is not an unusual occurrence. Many phytoplankton studies have reported the dominance of Bacillariophyceae in rivers and creeks of the Niger Delta and Nigeria. Such reports include Ogamba *et al.* (2004), Emmanuel and Onyema (2007), Abowei *et al.* (2008), Zabbey *et al.* (2008), Davies *et al.* (2009) and Nkwoji *et al.* (2010). Margalef (1968) had reported that species with the highest self-sustaining natural mechanisms of natural increase usually become dominant. This may account with the widespread dominance of Bacillariophyceae in both fresh and brackish waters.

## CONCLUSION

- The dominance of Bacillariophyceae in this study is not an unusual occurrence.
- Species with the highest self-sustaining natural mechanisms of natural increase usually become dominant.
- This may account with the widespread dominance of Bacillariophyceae in both fresh and brackish waters.
- The co-efficient of co-relation (R) was 0.48 (R<sup>2</sup>=0.234), an indication that both variables were poorly correlated.

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