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# Seasonal variation and plankton physico-chemical characteristics of Omeremaduche River, Abia state, Niger delta, Nigeria

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**Abstract**
Omeremaduche river was surveyed for Physico-chemical and planktonic characteristics for a period of thirty-four (34) weeks. Three sections of the River were sampled and human activities were considered in the choice of sampling stations. Statistical analysis was done using the Analysis of Variance (ANOVA). The influence of Physico-chemical characteristics on plankton distribution were evaluated using Pearson's Correlation. The mean values for pH, water-temperature, DO, BOD, phosphate and nitrate during the wet season were 6.91, 27.3, 5.86mg/l, 7.24mg/l, 0.38 and 4.18 respectively, while mean values of the same characteristics during the dry season were 6.68, 26.8, 7.22mg/l, 5.44mg/l, 0.25mg/l and 3.09mg/l. There was a significant difference in seasonal variation in DO, BOD, Nitrate and Phosphate, while there was no significant difference in pH and Water-temperature. The dry season variables were more favourable to plankton survival. Phytoplankton was characterized by four (4) phyla namely, Bacillariophyceae, Chlorophyceae, Euglenophyceae and Chrysophyceae while two (2) phyla Cladocera and Rhizopoda, represented the Zooplanktons. Bacillariophyceae recorded the highest number of individual species across the stations. The occurrence of plankton in Station 2, which is the point of dense anthropogenic activities, were less than what was obtained in the other sections. However, increased concentration of nutrients and dissolved oxygen were recorded in Station 3; this might have influenced the high plankton survival in the station. Changes in Physico-chemical characteristics of the River could be responsible for the varied plankton survival rate in the river. The seasonal variation may be attributed to varied rainfall patterns, while the partial variation may be due to the influence of various anthropogenic activities taking place around the river.

**Keywords:** River, anthropogenic activities, zooplankton, phytoplankton, physicochemical characteristics, and aquatic resources

## 1. Introduction
Plankton are a crucial food source for organisms in an aquatic ecosystem. Animals rely on aquatic food sources such as algae to support the food chain. They occupy the pelagic zone of the water column, which is named after its pelagic inhabitants. As the base of the food chain, the balance of energy in aquatic ecosystems is dependent upon the supply of plankton in the pelagic zone of the water column [39]. They are microscopic plants and animals whose motions are controlled by the water current. They are sensitive to temperature, dissolved oxygen, turbidity, rainfall and other ecological factors. Change in these environmental conditions could be amplified by activities like deforestation, thermal discharges from industrial plants, which in turn affects spawning grounds, physiological processes of aquatic organisms and the disruption of important biological communities [5]. Water quality is important in the distribution, occurrence and varieties of aquatic organisms. A short exposure of planktons to poor water quality causes alteration in the community structure, due to the elimination of the species that are intolerant to stress and proliferation/extreme stress-tolerant species would lead to their mortality [5]. The physiochemical characteristics of water may directly/indirectly influence its quality and consequently its suitability for production of fish species and other aquatic organisms. Increasing urbanization/industrialization has increased pressure on the ecological level of the ecosystems leading to minimal benefits [10]. Plankton decreases in streams close to farms than in those running through forests which shows that contamination was identified to cause the reduction.

Land activities may introduce large amounts of sediments into nearby streams and rivers. Sediment addition has been found to affect plankton, by reducing available habitat area [4, 22]. Planktons are of great importance in bio-monitoring of pollution; their distribution, abundance, species diversity and composition are used to access the ecological integrity of the aquatic ecosystem [12, 34]. Aquatic ecosystem performs a variety of biological, chemical and physical processes, which creates multiple benefits to water bodies and man. Therefore, the ecological integrity of a water body is of great importance to every living organism. Sustainable aquatic ecosystem management aims to ensure that water bodies function in a way as they do in natural catchments. The plankton composition, when observed can provide an indication of environmental health, for instance, algal bloom which is associated with eutrophication, especially during large phytoplankton blooms/over-nutrient fertilization known as "red tides". During tides, some organisms disappear completely as water quality deteriorates and the total number of species and number of different organisms found in the water body also decreases/dies [18, 19]. An assessment of both functional and structural components of the ecosystem gives a broader picture of the ecosystem's health. Living organisms' response has been applied in biodiversity studies as bio-indicators to climatic variability and trend [19].

[19] Observed that since the water level is often linked to important life cycle stages, wetland organisms could be used as indicators of climatic changes and hydrologic conditions overtime. An important characteristics of a river, is its biological diversity. [38] Reported that chemical measurement reflects water quality at a given time while biological assessment reflects conditions that have existed in a given environment over a long period of time.

[29] Studies in Ekole River, Bayelsa State revealed that Bacillariophyceace dominated the phytoplankton while Rotifers dominated the zooplankton specie with 37.35% and 41.45%, respectively. The presence of increased nutrient through runoff during the rainy season might have caused a more diverse plankton community in the rainy season and this implies an increase in primary productivity in the wet season. The stations with lowered phytoplankton diversity were very close to oil flow stations [11]. The zooplankton showed less species diversity and abundance than the phytoplankton. This may be related to their differences in tropical levels as primary producer and consumers respectively [13].

[3] In wawan Rafi Lake, the phytoplankton community was represented by four phyla; namely Chlorophyta followed by Cyanophyta with Bacillariophyta and Euglenophyta being the least represented. The dominating presence of Chlorophyta shows gradual deterioration of the water quality. This could be due to lots of anthropogenic activities such as chemical and waste washed into it [6]. Reported that in lakes where domestic agricultural and industrial pollution is accelerated, growth of Chlorophyta and cyanophyta results [2]. Indicated that Euglenophyta were common in an environment rich in decaying organic matter and a large population of Euglena were favored by the presence of high level of dissolved organic compound and high temperature. According to [34] the increase in abundance of Cyanophyta and Euglenophyta is an indication of organic pollution [17]. Reported that phytoplankton was dominated by Bacillariophyceae which contributed about 55.81% with Cyanophyceae (18.6%) Chlorophyceae (13.95%) Dinophyceae (6.97%) and Euglenophyceae (4.65%). Bacillariophyceae was observed in both wet and dry season. The possible reason for this may be its resilient ability to withstand the varied environmental factors [35]. Observed that among total Zooplanktonic organisms, Rotifers came third in order of abundance in Gandhisagar reservoir. These exhibited a bimodal pattern with a major peak in December and a minor peak in August; also observed that among total Zoo-planktonic population, Cladocera came second in order of abundance in Gandhisagar reservoir, except Diaphanosoma and Daphnia, No Cladoceran was recorded in the winter season, this may be as a result of low temperature and other physico-chemical factors, while a peak was recorded in summer [24] reported composition of Zooplankton of Makwaye as Cladocera was represented by Daphnia. Rotifers were represented by Keratella and Branchionus species with keratella forming the most abundance species. Copepoda was represented by Diaptomus species, Cyclops species and Nauplus larvae were the most abundant. According to [23] the Zooplankton community in Eruvbi stream, Benin City was composed of forty (40) species. Nine of Cladocerans, and Copepods and twenty two species of Rotifers. There was low species diversity and abundance of Zooplankton in the polluted stations. The most frequent Zooplankton species in the polluted part of the stream were the Rotifers, Branchionus spp and *Testudinella patina*. The numerical abundance of Rotifers in aquatic environment has been attributed to their pelagic reproduction pattern with short life span under favorable conditions and a wide range of tolerance to fluctuation of environmental factors [36] and [28]. The presence of clean water indicators species as Mesocyclops and Nauplius for good water quality [26]. The low Zooplankton densities of 15-55 individual/L as recorded by [23] is within the range found by [21], who reported Zooplankton densities of between 0.00-64org/L in Challawa River Kano [14]. Recorded four (4) orders of Zooplanktons namely Cladocera, Copepoda, Calanoida and Rotifera.

**The Aim of this study was to**

1. Investigate the seasonal variation of physico-chemical characteristics of Omeremaduche River.
2. Determine the plankton composition of the river.
3. Determine the relationship between changes in physico-chemical characteristics and plankton abundance of the river.

## 1.1 Materials and Methods

### 1.1.1 Study area

The study was conducted at Omeremaduche River in Isuochi, Umunneochi Local Government Area, Abia State. It is located about two (2) kilometers from Eke Isuochi market Amuda. The study area lies between latitudes 05˚26'00" and 05˚4'00"N and longitudes 07˚12'00" and 07˚20'00"E. Its terrain is sloppy and prone to erosion. The river has an average depth of about 2.5 meters. It is a perennial freshwater ecosystem and its water volume decreases during the dry season (Fig. 1).

### 1.1.2 Sampling stations

Station 1 is located at the upper course of the River, where human activities were not obvious; Station 2 is located at the area where human activities are higher such as the washing of clothes, bathing and sand dredging are taking place. Station 3 is located at the lower course of the River, where agricultural activities are going on. Sampling was carried out twice a month, from July, 2018 to February, 2019 covering wet and dry seasons.

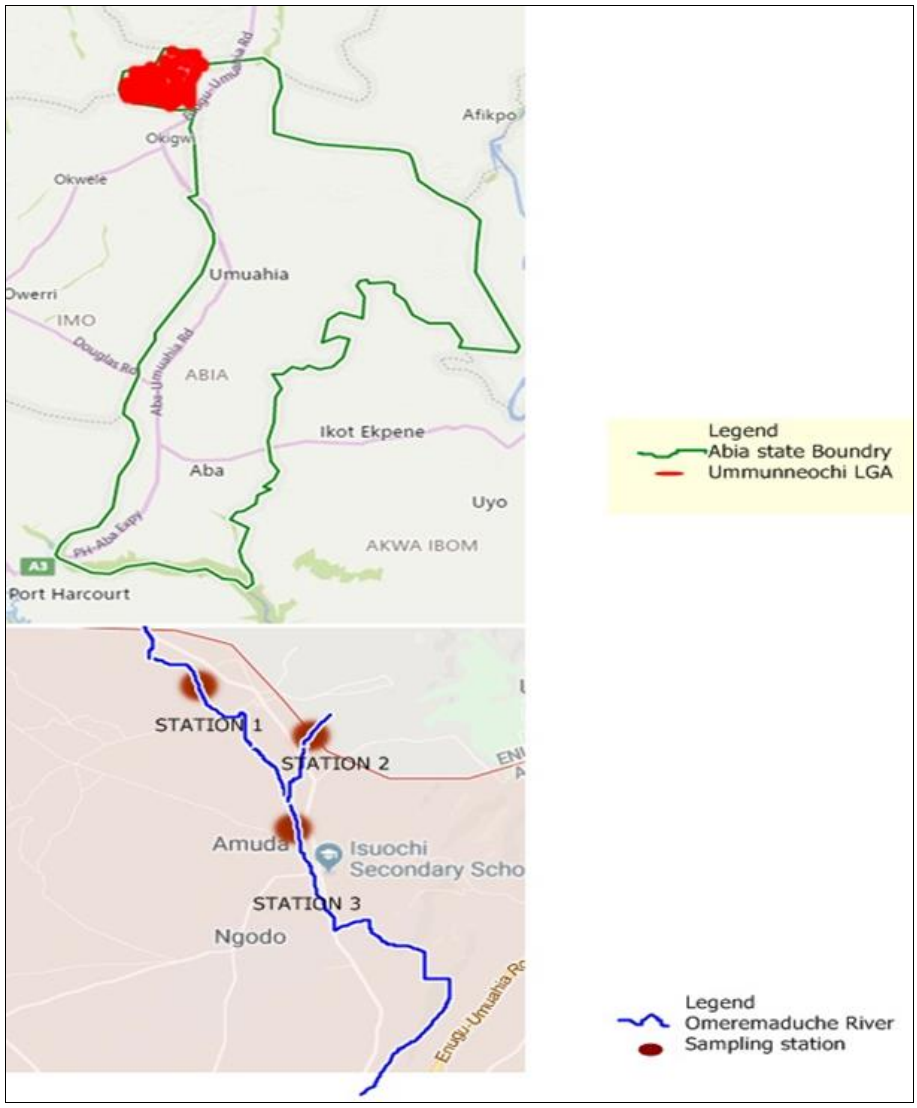


**Fig 1:** Map of study Area (Source: Administrative Umunneochi LGA), Abia State, Nigeria.

### 1.1.3 Determination of Physico-chemical characteristics

#### 1.1.3.1 Water temperature

The temperature was determined in-situ using mercury in a glass thermometer. This was done by lowering the thermometer bulb into the water below for about 2 to 5minutes and taking its stable reading [7].

#### 1.1.3.2 Water pH

The hydrogen ion concentration (pH) was measured in-situ with a pH meter. This involved probing the electrode of the pH into the water for about 3 to 5 minutes and taking its stable reading [7].

#### 1.1.3.3 Dissolved oxygen (DO) and biochemical oxygen demand (BOD)

Hannah instrument model H19025Cwas used to measure Dissolved Oxygen in-situ. A specialized 300ml BOD bottles designed to allow full filling with no air space were filled with the sample to be tested. [7, 27].

#### 1.1.3.4 Phosphate-phosphorus

This was determined using the Deniges method [7].

#### 1.1.3.5 Nitrate - nitrogen

One hundred (100) ml of water sample was poured into a crucible, evaporated to dryness and cooled. 2 ml of phenoldisulphonic acid was added and smeared around the crucible, after 10 minutes, 10ml of distilled water was added, followed by 5ml of strong ammonia solution, setting the spectrophotometer at the wavelength of 430nm.The concentration of nitrate-nitrogen was obtained from the calibration curve in mgl-1 [7].

### 1.1.4 Plankton

For the plankton analysis, the samples were collected by filtering thirty (30) liters of water through a plankton net of 55µm and concentrated up to 100ml [31, 7]. The concentrated plankton samples were preserved immediately with the help of 4% formalin in the field immediately before it was taken to the laboratory for identification and analysis. The samples were observed under the microscope, planktons were identified using standard keys [16, 31].

### 1.1.5 Statistical analysis

Analysis of variance (ANOVA) was used to test for significant differences occurring in various Physico-chemical characteristics between seasons, months and stations. Fisher's Least Significant Difference (FLSD) was used to separate the mean difference. Pearson's Correlation was used to test the relationship between Physico-chemical characteristics and plankton composition of the river. Statistical packages SPSS and Microsoft Excel were used. A significant level was taken at $P< 0.05$.

## 2. Results

### 2.1 Monthly variation in plankton occurrence

Bacillariophyceae was represented by *Asterionella formosa, Cyclotella comta, Cymbella tumida, Melosira varians, Surirella elegona and Synedra ulna* Ithad, highest occurrence was in the month of December and the lowest in the month of September. Euglenophyceae was represented by *Euglena acus.* It was high during the months of the dry and wet season, but a decrease was observed in October. Chlorophyceae was represented by *Chlamydonomas atactagon and Vovox aureus.* It had its highest occurrence in December and lowest in October. Chrysophyceae was represented by *Uroglena volvox.* It was high during the months of the dry and wet season but decreased in October and November. Cladocera represented by *Alona affinis, Bosmina longirostris and Dapnia pulex.* It was highest in January and lowest in September. Rhizopoda was represented by *Amoeba chaos, Amoeba clavakoidea and Centropyxis aculeate.* It was highest in November and lowest in October (Fig.2).

### 2.2 Variation in Physico-chemical characteristics among stations

From the study (table 3), pH was highest (7.15±0.37) in Station 1 and lowest (6.57±0.29) in Station 2, Standard error of the mean showed a significant difference in the pH values across the station. The temperature had its highest value (27.55±1.03) in station 1 and lowest value (26.71±1.53) in Station 3. The highest value for Dissolved Oxygen (DO) (6.81±2.3) was recorded in Station 3 and the lowest (6.04±2.1) in Station 2. The biological Oxygen Demand (BOD) of the River was highest (6.75±1.1) in Station 2 and lowest (6.08±0.9) in Station 3. Phosphate was highest (0.44±0.1) in Station 3 and lowest (0.17±0.06) in Station 1. Nitrate concentration was highest (4.17±0.62) in Station 3 and lowest (3.1±0.75) in Station 1.

### 2.3 Variation in Physico-chemical characteristics of wet and dry seasons among stations

The results of the Physico-chemical Parameters of the study Area are shown in (table 1), from the study, the mean pH value was highest (7.28±0.4) in the month of October and lowest (6.36±0.23) in the month of February. The temperature had its highest value (28.93±0.5 $^{o}$C) in the month of February and lowest (25.41±0.27 $^{o}$C) in the month of December. The highest value for Dissolved Oxygen (7.53±0.35mg/l) was observed in the month of January and the lowest value (5.63±0.38) was observed in the month of October. Biological Oxygen Demand in the River was highest (7.66±0.21) in the month of July and lowest (5.27±0.35) in the month of January. Phosphate was most elevated (0.41±0.1) in the month of October and lowest (0.19±0.08) in the month of February. Nitrate concentration was highest (4.57±0.14) in the month of August and lowest (2.82±0.68) in the month of February. The mean seasonal variation values of the physic-chemical parameter studies are shown in table 2. A higher mean pH value of (6.91±0.24) was observed during the wet season, this value was well contributed to by October, which recorded the peak value for pH in its monthly variation. The mean Temperature value of (27.3±0.77) was observed in the wet season, while mean value of (26.8±1.62) was observed in the dry season. The observation of lower mean temperature in December and January greatly reduced mean value for the dry season. Mean Dissolved Oxygen was higher in the dry season (7.22±2.95), with a peak value of (7.53±0.35) in the month of January. Mean Biological Oxygen Demand (7.24±0.88) was higher in the wet season, the month of July contributed to this by recording a peak value of (7.66±0.21) as its mean monthly value. Phosphate and Nitrate levels were (0.38±0.14) and (4.18±0.6) respectively; this was significantly higher than the values recorded in the dry season of 0.25±0.12 and 3.09±9.65 respectively.

### 2.4 Occurrence of Plankton among stations

Bacillariophyceae was highest in Station 3 and lowest in Station 2. This was the same for other groups of phytoplanktons. This is as shown in (fig. 3). For Zooplanktons Cladocera was highest in Station 3 and lowest in Station 1, while Rhizopoda was highest in the Station 3 and reduced in Station 2.

### 2.5 Seasonal variation of Plankton

All the other groups of phytoplankton were more during the dry season except Chrysophyceae, which had same mean seasonal occurrence. This is as shown in fig. 4. For Zooplanktons, Cladocera and Rhizopoda recorded more mean numbers of seasonal occurrence during the dry season.

### 2.6 Correlation of Physico-chemical Characteristics and plankton during the wet and Dry Seasons

The study revealed that *Bacillariophyceae* shows a positive association with all the physicochemical parameters. *Chlorophyceae* shows a positive response to pH and Temperature but negatively responded to Dissolved Oxygen and Biochemical Oxygen Demand during the dry season. The Zooplankton responded significantly to pH, Dissolved Oxygen, BOD, and Nitrates during the dry season. The phytoplankton showed a positive correlation to pH and Temperature during the dry season (Table 5). During the wet season, *Bacillariophyceae* showed a direct weak association with pH and BOD. *Chlorophyceae* showed a positive relationship with BOD and a negative with phosphate. *Euglenophyceae* correlated positively with all the parameters except pH. *Chrysophyceae* correlated negatively with pH and nitrates. The zooplankton showed a positive correlation with temperature in the wet season (table 6).

**Table 1:** Seasonal Variation in Physico-chemical Characteristics of Omeremaduche River

| Physico-chemical Characteristics | Wet season | | | | Test of significance |
|---|---|---|---|---|---|
| | Months | | | | |
| | July | August | September | October | |
| pH | 6.86±0.2$^{ac}$ | 6.89±0.27$^{ac}$ | 6.65±0.3$^{c}$ | 7.28±0.4$^{a}$ | 2.23$^{**}$ |
| Temp | 27.73±0.45 | 26.8±0.98 | 26.89±0.42 | 27.87±0.9 | 1.4$^{**}$ |
| DO | 6.08±0.51 | 5.77±0.57 | 5.96±0.74 | 5.63±0.38 | 0.53$^{**}$ |
| BOD | 7.66±0.21$^{a}$ | 7.14±0.34$^{a}$ | 7.06±0.74$^{a}$ | 7.1±0.32$^{a}$ | 11.20$^{*}$ |
| $PO_4$ | 0.4±0.17 | 0.32±0.21 | 0.36±0.14 | 0.41±0.1 | 0.17$^{**}$ |
| $NO_3$ | 4.14±0.65 | 4.57±0.14 | 4.1±0.82 | 3.94±0.56 | 0.69$^{**}$ |

Monthly values with the same superscript in same row and same season are not significant at 5% probability * = significant, ** = not significant

**Table 2:** Seasonal Variation in Physico-chemical Characteristics of Omeremaduche River

| Dry season | | | | | |
|---|---|---|---|---|---|
| **Physico-chemical Characteristics** | **Months** | | | | **Test of significance** |
| | **November** | **December** | **January** | **February** | |
| pH | 6.76±0.75 | 6.99±0.2 | 6.6±0.3 | 6.36±0.23 | 0.81** |
| Temp | 27.29±0.96 | 25.41±0.27 | 25.53±0.47 | 28.93±0.5 | 8.5** |
| DO | 7.33±0.61 | 7.06±0.62 | 7.53±0.35 | 6.93±0.55 | 0.6** |
| BOD | 5.63±0.38 | 5.59±0.32 | 5.27±0.35 | 5.54±0.1 | 2.96** |
| $PO_4$ | 0.29±0.16$^{a}$ | 0.3±0.1$^{a}$ | 0.22±0.11$^{b}$ | 0.19±0.08$^{b}$ | 0.63* |
| $NO_3$ | 3.02±0.68$^{ab}$ | 3.46±0.14$^{a}$ | 3.07±0.96$^{ab}$ | 2.82±0.68$^{b}$ | 0.8* |

Monthly values with same superscript in same row and same season are not significant at 5% probability * = significant, ** = not significant

**Table 3:** Seasonal Variation in Physico-chemical Characteristics of Omeremaduche River

| **Characteristics** | **Seasons** | | **Test of significance** |
|---|---|---|---|
| | **Wet** | **Dry** | |
| pH | 6.91±0.24 | 6.68±0.48 | ** |
| Temp | 27.3±0.77 | 26.8±1.62 | ** |
| DO | 5.36±0.52 | 7.22±2.95 | * |
| BOD | 7.24±0.88 | 5.44±0.37 | * |
| $PO_4$ | 0.38±0.14 | 0.25±0.12 | * |
| $NO_3$ | 4.18±0.6 | 3.09±9.65 | * |

* = significant at $p < 0.05$, ** = not significant

**Table 4:** Variation in Physico-chemical Characteristics among Stations

| **Characteristics** | **Stations** | | | **Test of Significance** |
|---|---|---|---|---|
| | **1** | **2** | **3** | |
| pH | 7.15±0.37$^{a}$ | 6.57±0.29$^{b}$ | 6.68±0.33$^{b}$ | * |
| Temp | 27.55±1.03 | 26.91±1.29 | 26.71±1.53 | ** |
| DO | 6.76±2.35 | 6.04±2.1 | 6.81±2.3 | ** |
| BOD | 6.3±0.65 | 6.75±1.1 | 6.08±0.9 | ** |
| $PO_4$ | 0.17±0.06$^{a}$ | 0.3±0.07$^{b}$ | 0.44±0.1$^{c}$ | * |
| $NO_3$ | 3.1±0.75$^{a}$ | 3.65±0.81$^{ab}$ | 4.17±0.62$^{b}$ | * |

Monthly values with same superscript in same row and same season are not significant at 5% probability * = significant, ** = not significant

**Table 5:** Correlation of Physico-chemical Characteristics and plankton during the Dry Season

| **Physico-chemical Characteristics** | | | | | | |
|---|---|---|---|---|---|---|
| **Plankton Groups** | **pH** | **Temp.** | **DO** | **BOD** | **$PO_4$** | **$NO_3$** |
| *Bacillariophyceae* | 0.5865 | 0.0384 | 0.0583 | 0.5160 | 0.1055 | 0.8542 |
| *Chlorophyceae* | 0.1926 | 0.2479 | -0.5331 | -0.1770 | -0.1745 | 0.3615 |
| *Euglenophyceae* | 0.3918 | 0.2717 | 0.2303 | 0.5488 | -0.1238 | 0.7629 |
| *Chrysophyceae* | 0.0168 | 0.1621 | -0.8396 | -0.5640 | -0.1546 | 0.0151 |
| *Cladocera* | 0.0868 | 0.5538 | 0.1815 | 0.3435 | -0.4250 | 0.5195 |
| *Rhizopoda* | 0.3738 | -0.0887 | 0.9306 | 0.9593 | 0.1878 | 0.5934 |

**Table 6:** Correlation of Physico-chemical Characteristics and Plankton during the Wet Season

| **Physico-chemical Characteristics** | | | | | | |
|---|---|---|---|---|---|---|
| **Plankton Groups** | **pH** | **Temp.** | **DO** | **BOD** | **$PO_4$** | **$NO_3$** |
| *Bacillariophyceae* | 0.3660 | 0.5926 | -0.3588 | 0.2227 | -0.0190 | 0.2430 |
| *Chlorophyceae* | -0.7202 | -0.0281 | 0.5840 | 0.9581 | -0.4017 | 0.8480 |
| *Euglenophyceae* | -0.6501 | 0.3551 | 0.7659 | 0.9521 | 0.1040 | 0.4726 |
| *Chrysophyceae* | -0.5912 | 0.0855 | 0.4667 | 0.9181 | -0.3701 | 0.8211 |
| *Cladocera* | 0.4091 | 0.4497 | -0.4841 | -0.4841 | -0.1711 | 0.3021 |
| *Rhizopoda* | -0.1982 | 0.6430 | 0.3281 | 0.7351 | 0.1631 | 0.3610 |

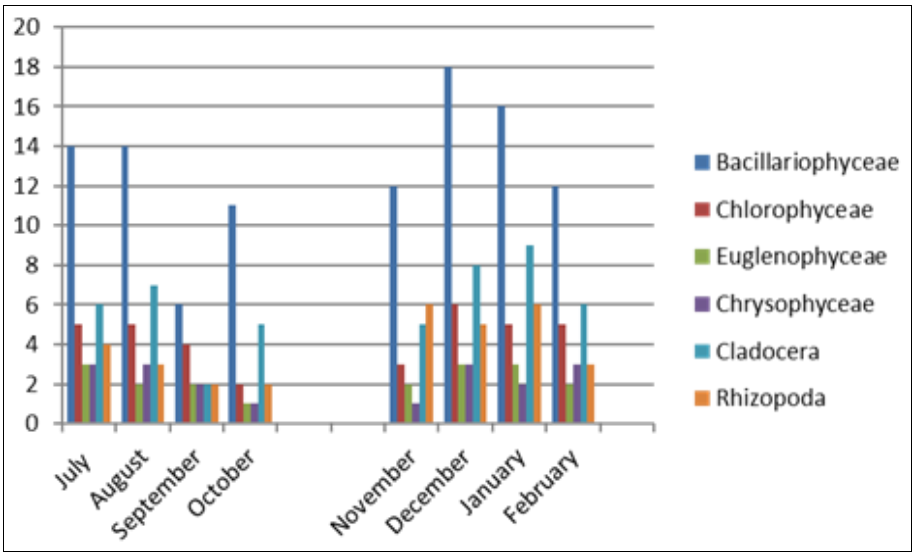


**Fig 2:** Monthly variation in plankton occurrence

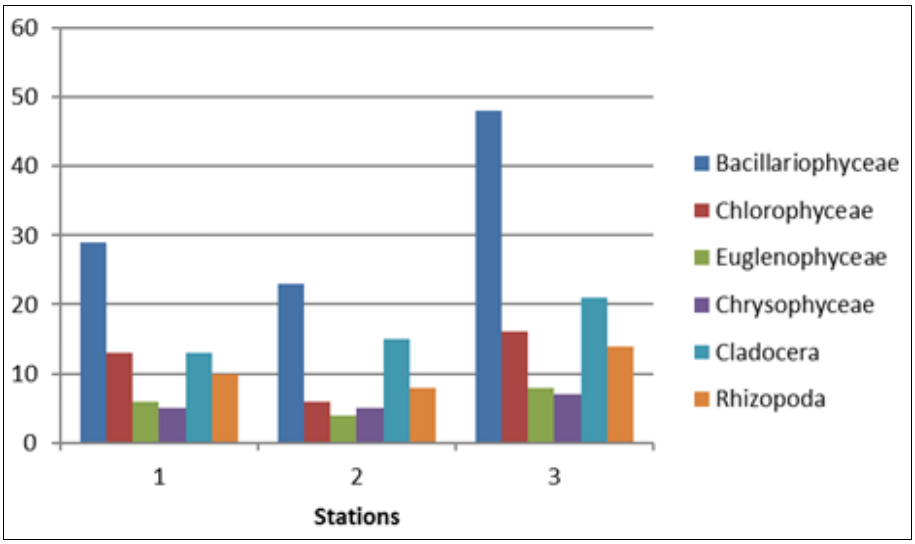


**Fig 3:** Occurrence of plankton among stations

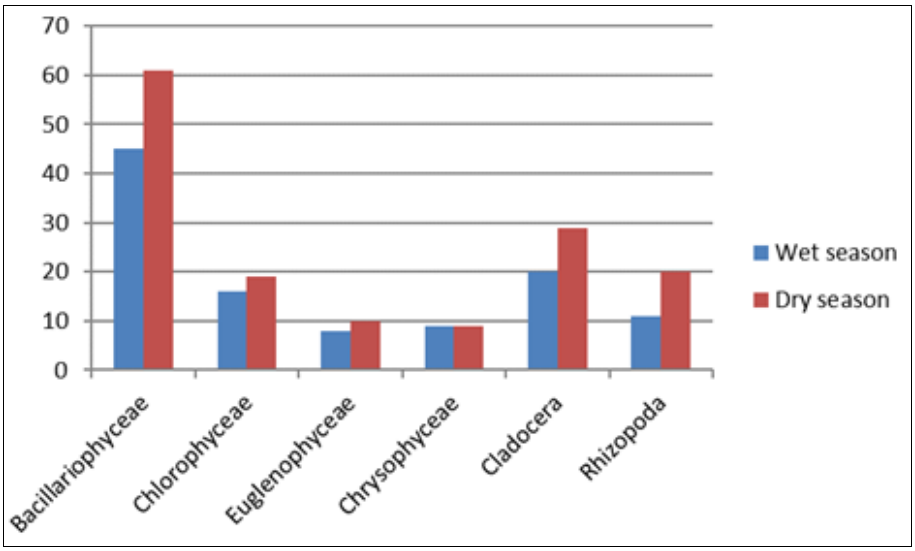


**Fig 4:** Seasonal variation of plankton in Omeremaduche River

**2.7 Identification of plankton species**

Below are the planktonic species that were identified in Omeremaduche River.

*Bacillariophyta* species:

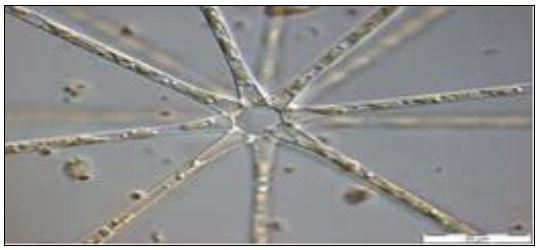

**Plate 1:** *Asterionella Formosa*

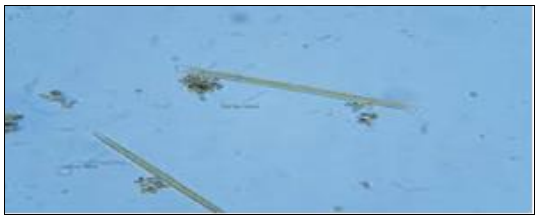

**Plate 2:** *Synedra ulna*

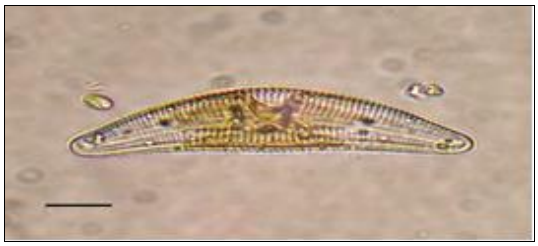

**Plate 3:** *Cymbella tumid*

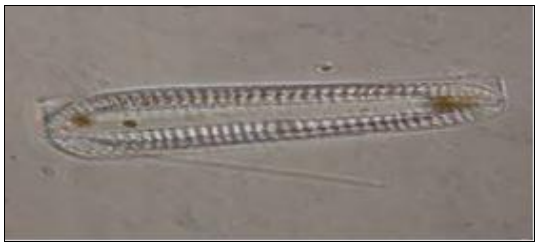

**Plate 4:** *Surirella elegans*

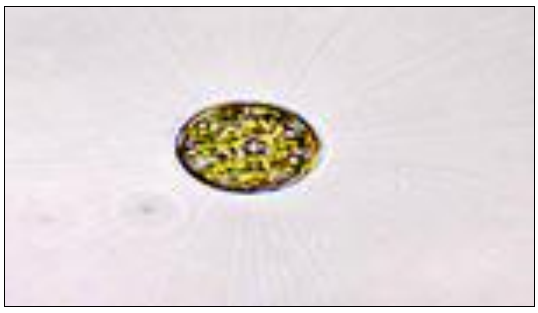

**Plate 5:** *Cyclotella comta*

**Plate 6:** *Melosira varians*

***Chlorophyta* species**

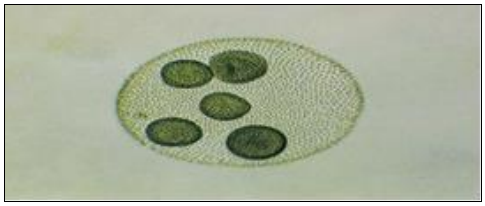

**Plate 7:** *Chlamydonomas atactagon*

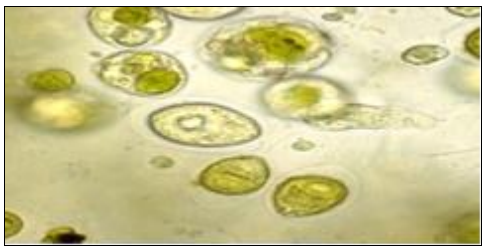

**Plate 8:** *Volvox aureus*

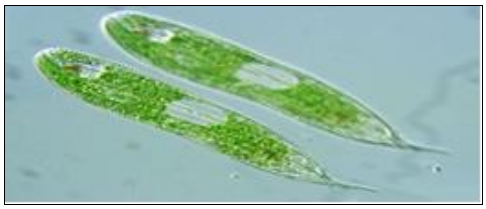

**Plate 9:** *Closterium moniliferum*

***Euglenophyta* species**

**Plate 10:** *Euglena acus*

***Chrysophyta* species**

**Plate 11:** *Uroglena volvox*

***Cladocera* species**

**Plate 12:** *Alona affinis*

**Plate 13:** *Daphnia pulex*

***Rhizopoda* species**

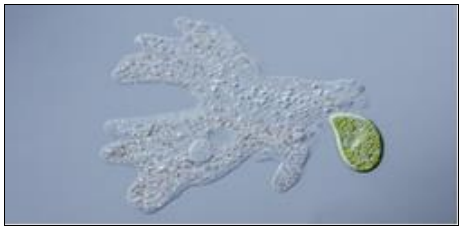

**Plate 14:** *Amoeba chaos*

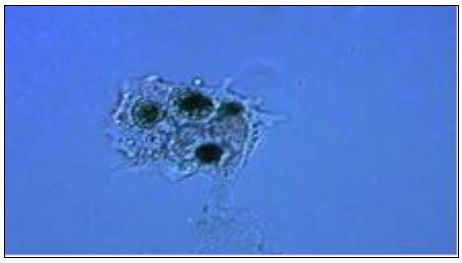

**Plate 15:** *Amoeba clavarioides*

**Plate 16:** *Centropyxis aculeata*

## 3. Discussion

From the findings, the phytoplankton composition in Omeremaduche River was characterized by four (4) phylas namely Bacillariphyta, Chlorophyta, Euglenophyta and Chrysophyta; eleven (11) species of phytoplanktons belonging to four families were identified, with Bacillariophyceae having the highest occurring species (6 species) others were Chlorophyceae characterized by 2 species) and Chrysophyceae and Euglenophyceae were characterized by one specie each. This result agrees with [29] on the study of plankton and Benthos of Ekoli River in Bayelsa state. Bacillariophyceae increased in occurrence in both wet and dry seasons. The possible reason for this may be its resilient ability to withstand the varied environmental factors [17]. Bacillariophyceae have been reported by many authors to be dominant in the phytoplankton composition as in the present study [32]. Seasonally its occurrence was found to be higher in the dry season and in Station 3. Chlorophyceae are mostly confined to shallow waters and are attached to submerged plants or form on moist soil [20]. Its seasonal occurrence ranged from 16-19 individuals occurring in the wet to dry season. The greater occurrence of Chlorophyceae species in the dry season may be attributed to the shallowness of the water during this period. Euglenophyceae increased during the dry season with a greater number of individuals recorded in station 3. [2] indicated that Euglenophyceae were common in environments rich in decaying organic matter and a large population of Euglena were favored by lower temperature. The absence of Chrysophyceae in Station 2 could be as a result of anthropogenic activities such as chemicals and waste washed into the River. The differences in a number of species between sampling stations for each class of phytoplankton may be due to differences in temperature and pH as different species obtain nutrients at different pH and temperatures also, the areas exposed to anthropogenic activities played a role in reducing the availability of phyto planktons. Zooplankton population in Omeremaduche River is characterized by Cladocera and Rhizopoda being represented by three and two species, respectively. Generally Zooplankton had its higher occurrence during the dry season. This could be due to the availability of food as phytoplankton on which they feed on is also abundant at this time. This observation is similar with the findings of [1] who researched on the Zooplankton community of Hadejia-Nguru wetlands. The availability of Zooplankton species decreased in Station 1 and 2. This might be due to anthropogenic activities going on around this area. The seasonal fluctuation of the Zooplankton population is a well-known phenomenon. In table 5, the results data showed steep variations in Physico-chemical characteristics amongst sampled stations of the River. The seasonal variations may be attributed to varied rainfall patterns, while the spatial variation may be due to the influence of various anthropogenic activities taking place around the River [8]. The mean range of pH was observed during the study period was 6.36 - 7.28 throughout both seasons and stations; this is in agreement with [15, 3, 27]. The composition/occurrence of zooplanktons of this river is not in consonant with (fig. 3) [9], they reported composition of zooplanktons of Makwaye water ecosystem. Thus, Cladocera was represented by Daphnia. Rotifers were represented by Keratella and Branchionus species with keratella forming the most abundance species. Copepoda was represented by Diaptomus species, Cyclops species and Nauplus larvae were the most abundant.

## 4. Conclusion

From the findings, the Physico-chemical parameters of Omeremaduche River during the study period were optimal for aquatic organisms. The results of the present investigation compared with literature values and it reveals that there is fluctuation in the Physico-chemical characteristics of the water. The activities around the sampling stations have a significant effect on the water quality as indicated by the variations in Physico-chemical characteristics of plankton composition.

## 5. Recommendations

In relation to the above findings, it is recommended that adequate monitoring of the water quality and regulations of anthropogenic activities, such as river dumping, sand diving, bathing and washing of plates/clothes, illegal fishing (the use of dynamites) in the river, is needed in order to slow down the aging process of the river; conserve its natural aquatic resources for a sustainable biodiversity for food security and stable livelihood of the inhabitants.

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