Investigation of phytoplankton distributions in the westernmost part of Barrier-lagoon-complex, Western Nigeria

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ABSTRACT

Distributions of phytoplankton were studied in two contiguous water bodies (Badagry Creek and Ologe Lagoon) within westernmost part of the Barrier-lagoon complex in Nigeria. Phytoplankton samples were collected and analysed using standard methods at five stations in each of the water bodies in September 2011, February and May 2012. Phytoplankton recorded from the two water bodies belonged to Classes Bacillariophyta, Chlorophyta, Cyanophyta and Euglenophyta. Total phytoplankton species of 92 and 94 were recorded in Badagry Creek and Ologe Lagoon respectively indicating relatively high diversity and productivity of the two water bodies. Bacillariophytes dominated the phytoplankton communities in the two water bodies constituting about 88% and 58% in Badagry Creek and Ologe Lagoon respectively. In terms of abundance, Badagry Creek was dominated by species only from the Class Bacillariophyta whereas each of the Classes Bacillariophyta, Chlorophyta and Cyanophyta had species with very high abundance in Ologe Lagoon. In Ologe Lagoon, two stations close to discharge points of municipal and abattoir wastes had low phytoplankton species number and diversity but high abundance of pollution indicator and harmful species of such genera as Volvox, Microcystis and Oscillatoria. The undesirable effects of the anthropogenic activities and the need to regulate them for sustainable management of the water bodies and the resources therein are discussed.

Keywords: Coastal waters, phytoplankton distribution, phytoplankton abundance, productivity, anthropogenic activities, harmful algae.

INTRODUCTION

Phytoplankton being the major group of primary producer organisms, are the bedrock of energy available for entire biological communities especially in coastal water bodies (Ama-Abasi and Akpan, 2006; Abowei et al., 2008; Yakub et al., 2011). Levels of abundance of various populations of phytoplankton in an aquatic ecosystem therefore indicate its level of productivity. Abundance, composition and distribution of phytoplankton of a coastal water body are often influenced by its physico-chemical conditions such as salinity gradients as well as concentrations of organic and inorganic ions (especially the nutrients). Indeed, excessive loading of natural water bodies with nutrients (nitrate and phosphate in particular) is a major cause of eutrophication which often results in phytoplankton or algal blooms (Abowei and Sikoki, 2005; Abowei et al., 2008; Onyema and Nwankwo, 2009).
In several cases, the bloom phytoplankton species include harmful ones which produce substances that are toxic either to finfish, shellfish, other aquatic higher animals or man, therefore posing significant socio-economic, health and ecological problems (Lefebvre et al., 2002; Abowei and Sikoki, 2005; Kadiri, 2011). According to the authors, production of the toxins by the harmful species is enhanced by high level of nutrients in the water body especially due to anthropogenic inputs. Thus, study of phytoplankton community, apart from providing information on productivity status, also serves as a good bio-monitoring approach for detecting and evaluating alterations in the physico-chemical conditions especially as a result of anthropogenic activities in the natural water bodies (Yakub, 2004; Abowei et al., 2008; Onyema and Nwankwo, 2009).

The Barrier-lagoon Complex which is constituted by a network of contiguous creeks and lagoons in the western part of Nigerian coastal zone, offers immense socio-economic benefits especially by supporting tremendous artisanal fishing activities. It also provides great opportunities and potentials for aquaculture. The barrier lagoon complex has however continued to experience environmental stress particularly from anthropogenic activities. This has resulted in significant undesirable ecological impacts in some parts of the complex such as the Lagos Lagoon (Ajao and Fagade, 2002; Ogunwemimo and Osuala, 2004; Nkwoji et al., 2010; Yakub et al., 2011).

Perhaps, although Yakub et al. (2013) reported on the physico-chemical parameters of the Badagry Creek and Ologe Lagoon, previous works on assessment of ecological status in the Barrier-Lagoon Complex have been concentrated mostly on the central part particularly the Lagos Lagoon. Considering the high level of human population growth rate with the concomitant increase in anthropogenic influences on coastal ecosystems especially in the western part of Nigeria. It is imperative to broaden the scope of ecological studies in the coastal waters. In order to bridge the gap of dearth of recent information on ecological conditions of this axis of Nigerian coastal zone, the present study investigated compositions and distributions of phytoplankton in Badagry creek and Ologe lagoon. The findings will be of immense benefit for effective and sustainable management of the coastal waters as well as provide basis for regulating various anthropogenic activities in the water bodies.

MATERIALS AND METHODS

Study area

The study was carried out in Badagry Creek and Ologe Lagoon within the western axis of the Barrier-Lagoon Complex in Nigeria (Figure 1). The Badagry Creek is the main body of the barrier lagoon complex that enters Nigeria (Figure 1). It has connections to the sea via Lake Nokoue in Cotonou and Lagos Lagoon and Harbor in Lagos. Ologe Lagoon on the other hand is a backwater into which some rivers and streams in the western part of Nigeria drain, and it in turn empties through some tributaries into the Badagry Creek and Lagos Lagoon (Figure 1).

Five stations were selected in each of Badagry Creek (stations A1 to A5) and Ologe Lagoon (B1 to B5) for sample collections. The sampling stations in Badagry Creek lie between Longitude 2° 52.51’E and 3° 06.3’E and Latitude 6° 24.48’ and 6° 24.78’N while those in Ologe Lagoon are between Longitude 3° 5.64’E and 3° 6.57’E and Latitude 6° 27.31’N and 6° 29.98’N (Figure 1). Littoral mangroves and coconut are the major vegetation of the study area in the Badagry Creek while Ologe Lagoon was characterized mostly by rooted and floating macrophytes as well as dense rainforest especially in areas with low anthropogenic activities.

Apart from sand mining and motorized boat operations which are major activities observed in the two water bodies, wastes from a major market in Badagry are discharged into Badagry creek at a location close to station A5. Ologe Lagoon receives municipal
effluents through drainage canals at Agbara (station B1) and wastes from an abattoir at Ijanikin (station B2).

**Collection and analysis of phytoplankton samples**

On each sampling occasion, standard plankton net of 52 µm mesh size, was suspended and towed steadily at low speed (<4knots) in the water at every station for 5 minutes. After towing, phytoplankton samples were concentrated and fixed under 4% unbuffered formalin. Fixed samples were allowed to settle in the laboratory for at least 24 h and the supernatant carefully decanted until a concentration of about 40 ml was obtained. With the aid of a Sedgwick Rafter counting chamber, 1 ml of water sample was analyzed using the drop count method. Phytoplankton species were examined, identified and counted using a Microstar IV Carl Zeiss binocular microscope calibrated at different magnifications (x10, x40 and x100 objectives). Identification was done using relevant and standard guides and text books of authors such as Wimpenny (1966), Compère (1976; 1977). Community structures of phytoplankton both in Badagry Creek and Ologe Lagoon were determined using diversity indices such as Margalef species richness (d) diversity and Shannon Wiener (H). The diversity indices values were computed as described by Ogbeibu (2005) using a computer software package, ‘Past’ by Hammer and Harper (2005).

Phytoplankton samples were collected from the two water bodies and analysed in the months of September 2011 as well as February and May 2012.

**RESULTS**

**Badagry Creek**

The phytoplankton recorded from Badagry Creek belonged to three classes: Bacillariophyta (Diatoms), Chlorophyta (green algae) and Cyanophyta (blue-green algae). A total of 92 species belonging to 43 genera and 10 orders were recorded. Distribution, abundance and diversity indices values of the phytoplankton at various sampling stations during the sampling periods as well as percentage compositions of various orders are presented in Table 1. The phytoplankton community was dominated by diatoms (Bacillariophytes) making up a total of 50 species from 24 genera with the two orders, Centrales and Pennales constituting 47.61% and 39.51% of the entire community respectively (Table 1). *Actinoptychus, Aulacoseira, Coscinodiscus, Gyrosigma and Surirella* spp had relatively high abundance across all stations especially in the months of February and May (Table 1). Other taxa of relatively high abundance during the period were *Amphiprora* and *Closterium* spp of the class Chlorophyta (Table 1). Among the blue-green algae, *Microcystis aeruginosa* was the most dominant in the wet season month of September; *Anabaena* was recorded only in the dry season while *Oscillatoria* had its distribution in the two seasons across the five stations (Table 1). Higher total species number and abundance levels were recorded across various stations in the dry season months of February and May than wet season month of September which however had relatively high diversity indices (Shannon-Wiener and Margalef) levels (Table 1).

**Ologe Lagoon**

The phytoplankton collected from Ologe Lagoon belonged to four classes (Bacillariophyta, Chlorophyta, Cyanophyta and Euglenophyta), 10 orders, 47 genera and 94 species. Table 2 presents distribution, abundance and diversity indices values of the phytoplankton at various sampling stations during the sampling periods as well as percentage compositions of various orders in Ologe Lagoon. Diatoms dominated the phytoplankton community both in terms of abundance and species composition (Table 2). Order Centrales of the diatoms constituted 49.96% of the total phytoplankton abundance (Table 2). *Aulacoseira* sp had the highest abundance with distributions cutting across all
Other phytoplankton taxa of relatively high abundance and wide distributions belonged to Cholorophyta (*Pediastrum, Eudorina* and *Closterium* spp.) and Cyanophyta (*Anacystis* and *Microcystis* spp.). *Microcystis*, however as well *Oscillatoria*, also a cyanophyte had relatively high abundance distributions at stations B1 and B2 through the sampling periods (Table 2). Highest phytoplankton species number, total abundance and diversity indices (Shanon-Wiener and Margalef) levels were recorded across the five stations in the month of May, followed by February while September had the lowest values for these parameters (Table 2).

Figure 1: Sampling stations in Badagry Creek and Ologe Lagoon.
Table 1: Abundance, distribution and diversity of phytoplankton in Badagry Creek (September 2011-May 2012).

| Composition | SEPTEMBER, 2011 | FEBRUARY, 2012 | MAY, 2012 |
|-------------|----------------|----------------|-----------|
|             | Badagry Creek | Badagry Creek | Badagry Creek |
| A1 | A2 | A3 | A4 | A5 | A1 | A2 | A3 | A4 | A5 | A1 | A2 | A3 | A4 | A5 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Division: Bacillariophyta**  |
| (Diatomaceae)  |
| **Order I: Centrales**  |
| Actinoptychus undulatus (Bail.) | 4 | 5 | 5 | - | - | 30,004 | 13,506 | 22,501 | 450 | 8,250 | 5,000 | 3,500 | 4,000 | 1,350 | 13,500 |
| Aulacoseira spp. | 1 | 3 | 36 | 16 | 6 | 2,000 | 1875 | 1618 | 16 | 2033 | 1 | 2 | - | 1 | 84 |
| Coscinodiscus spp. | 5 | 3 | 7 | - | 5 | 54 | 29 | 70 | 57 | 4 | 7529 | 8 | 19 | 7 | 7 |
| Cyclotella meneghiniana | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - |
| Odontella spp. | 3 | 7 | - | - | 3 | - | - | - | - | - | - | - | - | - | - |
| Skeletonema spp. | 1 | 6 | - | 9 | - | - | 1 | 1 | - | - | - | - | 4 | - | 850 |
| Terpsinoe musica (Ehr.) Hustedt | - | - | 2 | - | - | 3 | 3 | 4 | 4 | 24 | 4 | - | 5 | 1 | 5 |
| Gossleriella tropica Shütt | 6 | 7 | 5 | 1 | 2 | - | - | - | - | - | - | - | - | - | - |
| Rhizosolenia spp. | - | - | - | - | - | 2 | - | - | - | - | 1 | - | - | - | - |
| **Order II: Pennales**  |
| Fragilaria spp. | 1 | - | 3 | - | 4 | 1 | 5 | 1 | - | - | - | - | - | - | 1 |
| Synedra spp. | 1 | 3 | 3 | 1 | 3 | 6 | 15 | 8 | 8 | 4 | 3 | 5 | 3 | 6 | - |
| Tabellaria flocculosa | - | 1 | - | - | - | 1 | - | 1 | - | - | - | 1 | 5 | - | - |
| Thalassiothrix longissima | - | - | - | - | 3 | 6 | 8 | 2 | 3 | 3 | - | - | 3 | - | - |
| Gyrosigma spenceri | - | - | - | - | - | - | 1 | 1 | 2 | - | 7,000 | 1 | 3,000 | 1,500 | 1,200 |
| Navicula spp. | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Parabelius delognei (V.H.) E.J. Cox | - | 2 | 4 | - | - | 2 | 6 | - | 1 | - | - | - | - | - | - |
| Pinnularia spp. | - | - | - | - | 1 | - | - | - | - | 3 | - | - | - | - | 1 |

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| Species                        | Count | Length | Width | Height | Numbers | Division          | Order I: Chlorophyta |
|-------------------------------|-------|--------|-------|--------|---------|--------------------|----------------------|
| Pleurosigma angulatum         | 1     | 1      | -     | -      | 1       | Division: Chlorophyta |
| Stenopterobia rautenbachiae   | -     | -      | -     | -      | 1, 2    | Hydrodictyon sp.   | 0.0072               |
| Bacillaria paradoxa Gmel.     | 1     | 2      | 7     | 2      | 9, 6, 1 | Hydrodictyon sp.   |                      |
| Hantzschia sigma              | -     | -      | -     | -      | 1, 9    | Hydrodictyon sp.   |                      |
| Nitzschia spp.                | -     | -      | -     | -      | 2       | Hydrodictyon sp.   |                      |
| Campylodiscus clypeus var. bicostatus (Ehr.) Kutting | -     | 1      | 1     | -      | 2       | Hydrodictyon sp.   |                      |
| Surirella spp.                | 2     | -      | -     | 1      | 7, 600, 4,200, 12,000, 26,000, 29,500, 1000, 950, 1250, 2,300, 460 |                      |                       |
| **Division: Chlorophyta**     |       |        |       |        |         |                    |                      |
| **Order I: Chlorococcales**   |       |        |       |        |         |                    |                      |
| Hydrodictyon sp.              | 1     | 2      | 1     | 1      | -       | Hydrodictyon sp.   |                      |
| Pediastrum spp.               | 3     | 1      | 2     | 1      | -       | Hydrodictyon sp.   |                      |
| Scenedesmus spp.              | 2     | -      | 1     | 1      | -       | Hydrodictyon sp.   |                      |
| **Order II: Volvocales**      |       |        |       |        |         |                    | 0.0008               |
| Volvox globator               | 4     | 1      | 1     | -      | -       | Hydrodictyon sp.   |                      |
| **Order III: Zygnematales**   |       |        |       |        |         |                    |                      |
| (Conjugales)                  |       |        |       |        |         |                    |                      |
| Amphiphora costata            | -     | -      | -     | -      | -       | Amphiphora costata | 0.7072               |
| Closterium spp.               | 3     | 1      | 1     | -      | 2, 6    | Closterium spp.    |                      |
| Stauroastrum anatinum         | 2     | -      | 1     | 1      | 1       | Closterium spp.    |                      |
| Gonatozygion kinaudianii      | 2     | -      | 1     | 1      | -       | Closterium spp.    |                      |
| Spirogyra africana Fritsch Cruda | 3   | 2      | 7     | -      | 3       | Closterium spp.    |                      |
| **Division: Cyanophyta**       |       |        |       |        |         |                    |                      |
| **Order I: Chroococcales**    |       |        |       |        |         |                    |                      |
| Anacystis sp.                 | -     | 2      | -     | -      | -       | Anacystis sp.      | 12.113               |
| Eucapsis alpine               | -     | -      | -     | -      | 1, 1    | Eucapsis alpine    |                      |
| Microcystis aeruginosa Kutzing | 21   | 69     | 30,000| 20     | 42, 21, 1 | Microcystis aeruginosa Kutzing |                     |

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### Order II: Nostocales

| Species                     | 0.0096 |
|-----------------------------|--------|
| Anabaena spp.               | - - - - - - - - - 1 1 16 1 - - 1 |
| Nodularia spumigena Mertens | - - - - - - - - - 1 - - - - 3 |

### Order III: Oscillatoriales

| Species                        | 0.0418 |
|-------------------------------|--------|
| Cylindrospermum sp.            | - - - - - - - - - - - - - - 1 |
| Dactyliosolen antarcticus      | - - - - - - - - - 1 5 - - - - |
| Lyngbya martesiana Meneghini | - - 1 1 - - - - - - - - - - - |
| Oscillatoria spp.              | 1 3 8 - 2 3 5 5 1 2 38 3 7 11 3 |
| Spirulina spp.                 | - 1 - - - - - - - - - - 1 - 1 |

| Metric                          | Values  |
|---------------------------------|---------|
| Total species diversity (S)     | 19 23 26 9 18 25 31 26 24 23 27 14 27 18 32 |
| Total abundance (N)             | 52 120 30083 57 74 39691 19687 36245 26564 39847 21494 4486 9114 5186 16296 |
| Shannon-Wiener Index (Hs)       | 0.98 0.82 0.01 0.72 0.80 0.37 0.46 0.46 0.35 0.53 0.62 0.31 3.96 3.71 4.21 |
| Margalef Index (d)              | 4.56 4.60 2.42 1.98 3.95 2.27 3.03 2.38 2.26 2.08 2.61 1.55 2.85 1.99 3.20 |

- : Total Absence
Table 2: Abundance, distribution and diversity of phytoplankton in Ologe Lagoon (September 2011-May 2012).

| Division: Bacillariophyta | September, 2011 | February, 2012 | May, 2012 |
|---------------------------|-----------------|----------------|-----------|
|                           | Ologe Lagoon    | Ologe Lagoon   | Ologe Lagoon |
|                           | B1  B2  B3  B4  B5 | B1  B2  B3  B4  B5 | B1  B2  B3  B4  B5 |
| Order I: Centrales        |                 |                 |            |
| Actinoptychus undulatus (Bail.) | 3  5  -  3  -  2  -  1  1  3  -  -  5  -  1 | | |
| Aulacoseira spp.          | 3  19  48.5  40.0  162  5060 | 29.5  38.005  32.501  14.5  -  57.002  42.034  69.501  46950 |
| Coscinodiscus spp.        | -  3  1  -  6  -  -  1  2  12  -  -  8  8  9 | |
| Cyclotella meneghiniana   | -  -  -  -  -  -  -  -  -  -  -  -  -  -  - | |
| Hyalodiscus sp.           | -  -  -  2  -  -  -  2  -  -  -  -  -  -  - | |
| Melosira moniliformis     | -  -  -  -  -  -  -  -  -  -  -  -  -  -  - | |
| Terpsinoe musica (Ehr.) Hustedt | -  -  -  -  -  1  -  -  -  -  -  -  -  -  - | |
| Gossleriella tropica Shütt | -  1  1  -  8  -  -  -  -  -  -  -  -  -  - | |
| Rholosolenia spp.         | -  -  -  -  2  -  1  -  -  -  -  -  -  -  - | |
| Order II: Pennales        |                 |                 |            |
| Eunotia sp.               | -  -  -  -  -  -  7  -  -  -  -  -  -  -  10  7 | |
| Asterionella spp.         | -  -  -  -  -  -  1  -  -  -  -  -  -  -  -  -  1 | |
| Fragilaria spp.           | 1  3  -  1  -  -  -  1  -  -  -  -  -  -  -  -  -  - 1 | |
| Synedra spp.              | 1  1  1  3  1  2  2  -  -  1  -  1  3  7 | |
| Tabellaria flocculosa     | -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  - | |
| Thalassiothrix longissima | -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  - | |
| Gomphonema parvalum       | -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  - | |
| Navicula spp.             | 1  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  - | |
| Parabelius delognei       | -  3  -  2  -  -  -  -  -  -  -  -  -  -  -  -  -  -  - | |
| Pinnularia spp.           | 2  3  -  8  1  -  -  -  -  -  -  -  -  -  -  -  -  -  - | |
| Stenopterobia rautenbachiae | -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  - | |
| Bacillaria paradoxa Gmel. | 1  -  -  -  2  -  -  -  -  -  -  -  -  -  -  -  -  -  - 45,000 25,000 | |
| Nitzschia intermedia      | -  -  -  -  -  3  -  -  -  -  -  -  -  -  -  -  -  -  - | |
| Campylodiscus clypeus var. | -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  - | |
| bicostatus (Ehr.) Kutzing | -  1  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  - 45,000 25,000 | |
| Surirella spp. | - | - | - | - | - | - | - | 1 | 1 | 4 | - | - | - | 1 | 1 |
| Order: mischococcales |
| Goniochloris smithii | - | - | - | - | - | 1 | - | - | 2 | - | - | 1 | 2 | 1 | - |
| Division: Chlorophyta |
| Order I: Chlorococcales |
| Tetraëdron cruciatum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Pediastrum spp. | - | 13 | 11 | 6 | 1 | 15 | 15,616 | 5,304 | 2,359 | 2,254 | - | 15 | 29 | 850 | 900 |
| Scenedesmus spp. | - | - | - | - | - | 1 | 1 | 3 | 2 | - | 2 | 8 | - | - |
| Order II: VOLVOCALES |
| Eudorina cylindrical | - | - | - | - | - | 2,1 | 1,4 | 4 | 3 | 4 | - | 1,000 | 26 | 1,500 | 300 |
| Order III: ZYGEMATALES |
| Closterium spp. | - | 2 | - | - | - | 1 | 1 | 2 | 11252 | 34000 | - | 200 | 15 | 1 | - |
| Cosmarium subtilum var. oriculare | - | - | - | - | - | - | - | 4 | - | - | - | - | - | - | - |
| Staurostrum spp. | - | - | - | - | - | - | - | 8 | 6 | 7 | - | 1 | 1 | 2 | 1 |
| Goniaozymon kinahani | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Spirogyra africana Fritsch Cruda | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Division: CYANOPHYTA |
| Order I: CHROOCOCCALES |
| Anacystis sp. | - | - | - | - | 55,000 | - | 9 | 10,250 | 12,600 | 8,750 | 1,750 | - | 1 | 7,250 | 12,500 | 13,500 |
| Chroococcus disperses | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Eucapsis alpine | - | - | - | - | - | - | - | - | - | - | - | - | 6 | 3 | - |
| Microcystis aeruginosa Kutzing | 45 | 5 | - | 3 | 47 | 13,00 | 19,000 | 5,250 | 5250 | 763 | - | 16,500 | 8,250 | - | - |
| Order II: NOSTOCALES |
| Anabaena spp. | - | 3 | - | - | - | - | - | 1 | 1 | - | - | - | - | 6 | 20000 | - |
| Nodularia spumigena Mertens | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 250 | 18,000 |
| Order III: Oscillatoriales |
| Dactylicosolen antarcticus | - | - | - | - | - | 9 | - | - | - | - | - | - | - | - | - |
| Lyngbya martesiana | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Oscillatoria spp. | 65 | 69 | - | 1 | 1 | 4002 | 49 | 1 | - | - | 3 | 16 | 11 | - |
| Plankothrix sp. | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Division: Euglenophyta |

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### Order: Euglenales

| Species               | 0.0417 |
|-----------------------|--------|
| Phacus spp.           | -      |
| Strombomonas fluviatilis | -      |
| Trachelomonas verrucosa | -      |
| Total species diversity (S) | 9 27 8 13 13 29 21 19 22 22 0 17 33 29 26 |
| Total abundance (N)   | 426 4851 10469 |
| Shannon-Wiener Index (Hs) | 0.48 0.46 0.49 0.74 0.58 0.79 0.63 0.69 0.54 0.60 4.76 5.18 5.02 |
| Margalef Index (d)    | 2.4    |

- : Total Absence
DISCUSSION

The record of diatoms (Bacillariophytes) as the dominant phytoplankton class in the two water bodies both during rainy and dry seasons is typical of tropical aquatic ecosystems. Similar findings have been made in Nigerian coastal water bodies by previous workers such as Ama-Abasi and Akpan (2006), Abowei et al. (2008), Onyema (2008) and Yakub et al. (2011). The total abundance and number of species of phytoplankton recorded in each of the water bodies are relatively high compared with the findings in some other Nigerian coastal waters by earlier workers mentioned above.

The dominant diatom species recorded from the two water bodies were not listed by Kadiri (2011) among harmful algae of Nigerian coastal waters although the author’s study was carried out in highly saline onshore areas of the coastal zone. However, Coscinodiscus which was recorded from various stations in Badagry Creek during various sampling regimes although not in very high abundance had been reported as potential harmful algae by Kadiri (2011). The high total abundance and diversity generally recorded for the phytoplankton from both Badagry Creek and Ologe Lagoon during the two seasons is an indication of relatively high productivity and healthy ecological conditions in the water bodies.

The record of only diatoms as the dominant phytoplankton species in Badagry Creek while Ologe Lagoon had dominant species from three different classes of phytoplankton is an indication of variability in phytoplankton distributions in the two water bodies. The variability could be as a result of differences in salinity levels and profiles earlier reported from the same study areas of the two water bodies by Yakub et al. (2013). The authors recorded estuarine salinity in the entire study area of the Badagry Creek but a spatial salinity gradient from freshwater at stations B1 and B2 to brackish condition at station B5 in Ologe Lagoon. The occurrence of Bacillaria paradoxa at the entire five stations in Badagry Creek but only at stations B4 and B5 in Ologe lagoon is due to the fact that the two water bodies are linked at a place close to these stations.

The relatively high phytoplankton abundance recorded at most stations in the two water bodies during dry season month of February which conforms the finding of Yakub et al. (2011) in the Lagos Lagoon could be as a result of increased level of photosynthetic activity due to high level of photoperiod that characterizes the season. It is noteworthy that in each of the two water bodies relatively similar phytoplankton abundance and taxa distributions were recorded in the dry season month of February and early rainy month of May. Perhaps, this is attributable to the time lag between commencement of rains (usually in March/April) and onset of flooding which could have prolonged dry season environmental conditions in the water bodies till the month of May.

The relatively high levels of abundance distributions of pollution indicator species of green algae (Chlorophytes) such as Volvox globator and blue-greens (Cyanophytes) such as Microcystis and Oscillatoria at stations B1 and B2 in Ologe Lagoon are attributable to the drainage of municipal effluents and abattoir wastes into the water body close to these stations. These anthropogenic activities could have also resulted in the low phytoplankton abundance and species number obtained at station B1 compared to other stations in Ologe lagoon. Microcystis which occurred in high abundance at the two stations had earlier been recorded as one of the dominant harmful blue-
green algae in the entire Nigerian marine coastal ecosystems by Kadiri (2011).

The stations B1 and B2 had earlier been reported to have relatively high biochemical oxygen demand and nutrients (nitrate and phosphate) but low dissolved oxygen by Yakub et al. (2013). The authors attributed these to degradation of organic rich wastes being discharged into the water body close to these stations. Similar earlier reports of low phytoplankton abundance and diversity in organically polluted areas of Nigerian waters include those of Yakub (2004), Ama-Abasi and Akpan (2006), Abowei et al. (2008), Onyema (2008) and Yakub et al. (2011).

Conclusion

Badagry Creek and Ologe Lagoon in Nigerian westernmost part of the Barrier Lagoon Complex generally had relatively high diversity of phytoplankton with diatoms as dominant taxa. Phytoplankton compositions and distributions of the two water bodies varied somehow probably due to differences in their salinity profiles. Anthropogenically impacted areas of Ologe Lagoon (Stations B1 and B2) had relatively low phytoplankton species diversity as well as high abundance of pollution indicator and harmful phytoplankton species. In order to prevent further ecological deterioration and to ensure sustainable management of these water bodies, it is very imperative to control the level of anthropogenic activities such as the discharge of untreated municipal wastes especially into Ologe Lagoon.

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