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# Physico-chemical parameters, chlorophyll a and phytoplankton community as trophic state indices of two tropical lakes, southwestern Nigeria

**Adedolapo Abeke Ayoade [1*], Blessing O. Osuala [1], Temitayo A. Adedapo [1]**

[1] Department of Zoology, University of Ibadan, Oyo State, NIGERIA
*Corresponding author: kenpeadobece@gmail.com

**Abstract**

**Background:** Asejire and Eleyele Lakes are sources of water supply and used for fishing activities in southwestern Nigeria. However, various anthropogenic activities occur in their catchment area that could lead to deterioration of the ecological status. The purpose of this research was to determine the trophic status of the lakes (on which there is limited information) based on the environmental variables, chlorophyll a and phytoplankton assemblage.
**Methods:** Water samples were collected for six months and analyzed for total nitrogen, total phosphorus, chlorophyll a and phytoplankton. Other physicochemical parameters were determined *in situ*. The trophic level was calculated with the Carlson Formula. Phytoplankton data were analyzed to determine diversity indices using the Shannon Weiner and Margalef formula.
**Results:** The total nitrogen: total phosphorus ratio of the two lakes was interpreted that nitrogen could be the limiting factor for primary production. Trophic state index values from total phosphorus, chlorophyll a and Secchi disc transparency of both lakes exceeded the criteria at which lakes are interpreted as eutrophic. The dominance of blue green algae and abundance of green algae in both lakes further suggested they are eutrophic. The Shannon-Weiner and Margalef diversity indices for Eleyele and Asejire Lakes were H= 0.78, d = 8.78 and H= 0.72, d= 8.02, respectively.
**Conclusion:** These values suggested the lakes are in eutrophic condition. Future management activities need to reduce phosphorus load of the two lakes.

**Keywords:** Algae, Asejire and Eleyele Lakes, Eutrophication, Secchi disc transparency

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## INTRODUCTION

Trophic state is central to ecosystem structure and is inextricably linked to biotic integrity and water quality. The trophic status of lakes describes the development and functioning of aquatic organisms. It is a useful means of classifying lakes and describing lake processes in terms of the productivity of the system. In lakes, trophic state is functionally defined by factors related to autotrophic production including algal biomass, water column nutrients and water transparency (Pulina *et al*. 2011). Phytoplankton abundance and biomass in lakes tend to increase with trophic state, these escalations being preceded or accompanied by changes in the taxonomic composition of the community (Hutchinson 1967, Spodniewska 1978, Reynolds 1987, Trifonova, 1998 as cited by Szelag-Wsasielewska, 2007). Multiple reservoir uses and human activities at the watershed change the nutrient inputs that induce modifications of the reservoir's trophic state, biotic assemblages and physico-chemical conditions (Molisani *et al*. 2010). Eleyele and Asejire Lakes were created majorly for water supply and used for fisheries and any adverse change in their ecological status is of public concern. Several activities (including farming, bathing/washing, small food industry, cement making, car wash, etc.) that produce effluents which may cause adverse effects take place in the catchment areas. Previous studies on Eleyele and Asejire Lakes were on the physico-chemical and biological parameters (e.g. Egborge 1977a, 1977b, 1978a, 1978b, 1979a, 1979b, 1981, Godwin, 2016, Jenyo et al. 2016, Olanrewaju *et al*. 2017). To the knowledge of the authors, there are little or no previous work on the trophic status of these waterbodies. Hence, the aim of this study was to determine the trophic status of Eleyele and Asejire Lakes according to physico-chemical parameters, chlorophyll a and phytoplankton community data. This will enhance effective management and conservation of these ecosystems.

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**Table 1.** Features of Eleyele and Asejire Lakes

| Parameter | Eleyele Lake | Asejire Lake |
|---|---|---|
| Location | Ibadan | 30 km East of Ibadan |
| Latitude | 7° 23′ N– 7° 31′ N | 07°21′N |
| Longitude | 3° 25′ E– 3° 35′ E | 04°07′E |
| Elevation | 125 m | 137 m |
| Geology | Bedrock | Precambrian metamorphic rocks |
| Climate | Dry season: November to April<br>Rainy season: May to October | Dry season: November to April<br>Rainy season: May to October |
| Maximum length | 240 m | - |
| Maximum/ Average depth | 6 m | - |
| Catchment area | 323.7 $km^2$ | 7800 $km^2$ |
| Impoundment area | 156.2 hectares | 2342 hectares |
| Storage capacity | 29.5 million liters | 80 million liters |
| Mean temperature | 28.8℃ | 27.3℃ |
| Mean rainfall | 1981.2 mm | 14.7 mm |
| Mean humidity | - | 79 % |

Source: Elliot (1986); Ayoade *et al*. (2006); Olayinka *et al*. (2017)

### Study Areas

Eleyele and Asejire Lakes are in southwestern Nigeria. Eleyele Lake was formed (in 1942) by damming Ona River which is part of the dense network of inland water courses that flowed southwards into Lekki Lagoon. The reservoir basin is long and narrow and its divided into two main arms. On each side of the lake there is a stretch of forest reserve which terminates very near the lake on the western side. However, deforestation has occurred and small-scale food industries, mechanic workshop, block making factory, churches and residential area for artisanal fisherfolks are now found in the catchment area of the lake. Asejire Lake is (a manmade lake) constructed on River Oshun in 1972 and the river discharge into coastal lagoons and creeks bordering the Atlantic Ocean. The lake is Y-shaped with two unequal arms of the Y. Climatic conditions are typically tropical as the areas lies within the rainforest region. Rainy season begins in April and continues till October except for the fairly short period between August and September. The dry season is restricted to the period from November to March. Features of Eleyele and Asejire Lakes are shown on **Table 1**.

## MATERIALS AND METHODS

Water samples were collected monthly in Eleyele (April to September, 2017) and Asejire (May to October 2017) Lakes. The water samples were collected in triplicate in 1L polyethylene bottles that were prewashed and rinsed with lake's water before collection. The water temperature, dissolved oxygen and pH were determined *in situ* with SPER 850081 multi-parameter probe (Arizona, USA). The Secchi disc depth was determined using a 20 cm diameter disc (Wetzel and Likens 2000). The total phosphorus was determined after digestion of samples with sulfuric acid followed by ascorbic acid method (APHA, 1998). The chlorophyll a concentration of the prepared samples was determined spectrophotometrically using the acetone method (APHA, 1998). Water samples for analysis of phytoplankton (quantitative and qualitative) were collected with 30μm mesh size plankton net and preserved with 4% formalin. The phytoplankton were identified to genus level using standard guides. Phytoplankton abundance was determined using sedimentation method (Utermöhl 1958). The species richness (d) was calculated according to Margalef (1958), the species diversity (H) based on abundance of the species after Shannon-Weaver (1949). Trophic State Index (TSI) calculated using the measured Total Phosphorus (TP), chlorophyll a and Secchi Disc Transparency (SDT) were determined using the following equations:

$$TSI\ (TP) = 14.42\ \ln\ (TP) + 4.15$$

$$TSI\ (Chl\ a) = 9.81\ \ln\ (Chl\ a) + 30.6$$

$$TSI\ (SDT) = 60 - 14.41\ \ln\ (SD)$$

$$CTSI = TSI(TP)+TSI\ (SDT+TSI\ (Chl\ a)/3$$

Where TP is total phosphorus (μg/L); Chl a is chlorophyll a (μg/L); SDT is Secchi Disc Transparency (m); CTSI is Carlson Trophic State Index. Values less than 40 are associated with oligotrophy; a range between 40 and 50 is usually associated with the mesotrophy; index values greater than 50 are eutrophy Wetzel, 2001.

The trophic level was also determined using the approach introduced by Kratzer and Brezonik (1981), formulated below (as cited by Gupta, 2014):

$$TSI\ (TN) = 54.54 + 14.43\ln\ (TN)$$

where, TSI (TN) is trophic state index based on a calculation of total-N, TN is total nitrogen (μg/L). Kratzer and Brezonik (1981) classify the TSI (TN) value into 4 classes with TSI (TN)<20 being ultraoligotrophic, 30<TSI (TN)<40 oligotrophic, 53<TSI<60 eutrophic and TSI (TN)>70 hypertrophic (Harper 1992).

## RESULTS

### Physico-chemical Parameters

The surface water temperature ranged from 22.5 °C in May to 29.4°C in September in Asejire Lake. The temperature recorded in Eleyele Lake ranged between 26.2 to 28 °C (mean = 27.1 ± 0.89°C). Water was alkaline with pH range of 7.8 in June and 9.3 in August/September (Asejire Lake) and 7.2 in June/ July to 8.0 in May (Eleyele Lake). The mean dissolved oxygen for Asejire Lake was 6.8 ±0.6mg/L (range= 5.9 – 7.3 mg/L) and 7.1 ± 2.9mg/L (4.6 - 12.6mg/L) for Eleyele Lake. The mean SDT of Eleyele Lake (0.9±0.4m) was higher than Asejire Lake (0.33±0.04m) **Table 2**.

### Nutrient and Chlorophyll Concentrations

The nutrient concentrations of Asejire Lake (TP, 253.2±81.9 μg/L; TN, 101.9±66.9 μg/L) was higher than Eleyele Lake (TP, 71.75±52.7 μg/L; TN, 45±48.2 μg/L). Temporal variation occurred in nutrient concentrations. An increase in nitrogen concentration was observed

**Table 2.** Monthly variation in physicochemical parameters of Asejire and Eleyele Lakes

| | Temp(°C) | | DO (mg/L) | | pH | | SDT(m) | | Chl a(µg/L) | | TN(µg/L) | | TP(µg/L) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ASE | ELE | ASE | ELE | ASE | ELE | ASE | ELE | ASE | ELE | ASE | ELE | ASE | ELE |
| April | ND | 27.7 | ND | 12.6 | ND | 7.6 | ND | 1.2 | ND | 343.3 | ND | 26.7 | ND | 70 |
| May | 22.5 | 26.7 | 6.8 | 7.8 | 8.1 | 8.0 | 0.3 | 0.8 | 366.3 | 356.7 | 47 | 10 | 394 | 60 |
| June | 25.9 | 26.2 | 5.9 | 4.6 | 7.8 | 7.2 | 0.27 | 1.5 | 383.7 | 306.7 | 104 | 10 | 298.7 | 10 |
| July | 27.3 | 28 | 6.2 | 5.9 | 8.5 | 7.2 | 0.31 | 0.5 | 413.3 | 296.7 | 193.3 | 110 | 231.7 | 170 |
| August | 28.7 | 26.4 | 7.1 | 6.1 | 9.3 | 7.7 | 0.39 | 0.8 | 230 | 326.7 | 171.5 | 10 | 177.5 | 60 |
| September | 29.4 | 27.6 | 7.3 | 5.3 | 9.3 | 7.3 | 0.3 | 0.5 | 290.7 | 310 | 60 | 103.3 | 181.3 | 60 |
| October | 24.3 | ND | 7.2 | ND | 8.1 | ND | 0.31 | ND | 362 | ND | 35.6 | ND | 235.7 | ND |
| Mean ± SD | 26.4± 2.6 | 27.1 ± 0.8 | 6.8 ± 0.6 | 7.1 ± 2.9 | 8.5 ± 0.7 | 7.5 ± 0.3 | 0.3 ± 0.04 | 0.9 ± 0.4 | 341 ± 67.8 | 323.4 ± 23.2 | 101.9 ± 66.9 | 45 ± 48.2 | 253.2 ± 81.9 | 71.7 ± 52.7 |

Temp-Temperature; DO-Dissolved Oxygen; SDT- Secchi Disc Transparency; Chl a-Chlorophyll a; TN- Total Nitrogen; TP-Total Phosphorus; SD-Standard Deviation; ND-Not determined; ASE-Asejire Lake; ELE-Eleyele Lake

**Table 3.** Trophic State Indices of Asejire and Eleyele Lakes from Secchi Depth, Total Phosphorus and Chlorophyll a

| | Asejire Lake | | | | Eleyele Lake | | | |
|---|---|---|---|---|---|---|---|---|
| | TSI(SD) | TSI(TP) | TSI (CHL -a) | Carlson TSI | TSI(SD) | TSI(TP) | TSI (CHL -a) | Carlson TSI |
| April | ND | ND | ND | ND | 57.55 | 65.43 | 88.09 | 70.36 |
| May | 75.56 | 90.23 | 88.58 | 84.79 | 63.6 | 80.58 | 88.29 | 77.49 |
| June | 78.88 | 86.34 | 88.87 | 84.70 | 54.38 | 52.75 | 87.79 | 64.97 |
| July | 76.86 | 82.6 | 89.66 | 83.04 | 69.94 | 77.98 | 86.52 | 78.15 |
| August | 73.55 | 35.87 | 83.97 | 64.46 | 63.6 | 63.42 | 87.5 | 71.51 |
| September | 75.56 | 78.99 | 86.22 | 80.26 | 68.93 | 63.7 | 86.91 | 73.18 |
| October | 76.86 | 83.17 | 88.38 | 88.38 | ND | ND | ND | ND |
| Mean±SD | 76.21±1.8 | 76.2±20.1 | 87.6±2.1 | 80.9±8.5 | 63±6.1 | 67.3±10.3 | 87.5±0.7 | 72.6±4.9 |

TSI- trophic state index; SDT -Secchi disc transparency(m); TP- total phosphorus(µg/L); Chl a - chlorophyll a (µg/L)

**Table 4.** Correlation Coefficients of Some Physico-parameters with Chlorophyll a

| | Asejire Lake | | | | Eleyele Lake | | | |
|---|---|---|---|---|---|---|---|---|
| | SDT | TN | TP | CHL a | SDT | TN | TP | CHL a |
| SDT | 1 | -0.64 | -0.16 | 0.95 | 1 | 0.60 | 0.48 | 0.12 |
| TN | -0.64 | 1 | 0.86 | -0.38 | 0.60 | 1 | 0.18 | 0.50 |
| TP | -0.16 | 0.86 | 1 | 0.15 | 0.48 | 0.18 | 1 | 0.16 |
| CHL-a | 0.95 | -0.38 | 0.15 | 1 | 0.12 | 0.50 | 0.16 | 1 |

SDT- Secchi Disc Transparency; TN-Total Nitrogen; TP- Total phosphorus; CHL a- Chlorophyll a

**Table 5.** Total Nitrogen to Total Phosphorus Ratio

| | Asejire TN:TP | Eleyele TN:TP |
|---|---|---|
| April | - | 0.4 |
| May | 0.1 | 0.01 |
| June | 0.3 | 0.1 |
| July | 0.8 | 0.7 |
| August | 12.2 | 0.1 |
| September | 0.3 | 1.8 |
| October | 0.2 | - |

TN-total nitrogen; TP- total phosphorus

through May to July, followed by a gradual decrease in Asejire Lake. Total phosphorus concentration however decreased from May to August. In Eleyele Lake, decrease in nitrogen concentration was observed from April to June with peak in July. The phosphorus concentration did not show a definite trend. The mean chlorophyll a concentration of Asejire and Eleyele Lake were similar, 341±67.8 µg/L and 323.4±23.2 µg/L, respectively **Table 2**. The minimum value (230 µg/L) was recorded in August and maximum (383.7 µg/L) in June in Asejire Lake. In Eleyele Lake, chlorophyll a concentration was least in July (296.7 µg/L) and highest in May (356.7 µg/L). Trophic state indices derived from chlorophyll a were highest in both lakes; average TSI for Secchi depth (76.21) and P (76.2) were the same in Asejire Lake while TSI (TP), 67.3 was higher than TSI (SDT), 63 in Eleyele Lake **Table 3**. According to Carlson (1983) possible interpretations for the deviations between the indices is that, for the study lakes large particulates, such as *Aphanizomenon* flakes, dominate. Carlson TSI for the two lakes were greater than 70.

**The relationship between nutrient concentrations, Secchi disc transparency and primary production** as measured by chlorophyll a concentration was determined by linear regression and shown on **Table 4**. For Asejire Lake, significant positive relationship was observed between SDT and chlorophyll a ($r= 0.95$, $p=0.05$). The positive relationship between TP and chlorophyll a ($r=0.15$, $p=0.05$) was not significant suggesting no correlation. The relationship between chlorophyll a and TN was negative and insignificant. For Eleyele Lake, there was no correlation between chlorophyll a and TP ($r= 0.16$, $p=0.05$); and SDT ($r= 0.12$, $p=0.05$).

**Total Nitrogen to Total Phosphorus (TN/TP) Ratio.** The TN/TP ratio for Asejire and Eleyele Lakes ranged from 0.1 to 12.2(mean=2.32±4.84) and 0.01 to 1.8 (mean=0.52± 0.68), respectively **Table 5**.

**Table 6.** Percentage composition of phytoplankton in Eleyele and Asejire Lakes

| **Group/Genera** | **Abundance (%)** | |
|---|---|---|
| CYANOPHYCEAE | Eleyele Lake | Asejire Lake |
| *Rivularia* | - | 13.6 |
| *Anabaena* | 1.36 | 6.01 |
| *Oscillatoria* | - | 3.58 |
| *Nostoc* | 1.3 | 3.24 |
| *Spirulina* | - | 7.51 |
| *Polycystis* | 16.16 | 3.44 |
| *Microcystis* | - | 6.34 |
| *Aphanothece* | - | 0.94 |
| *Merismopedia* | 6.73 | - |
| *Phormidium* | 3.23 | - |
| *Coelospharium* | 0.5 | - |
| *Tetrapedia* | 4.95 | - |
| **Subtotal** | **34.23** | **44.66** |
| CHLOROPHYCEAE | | |
| *Spirogyra* | - | 7.27 |
| *Ulothrix* | - | 4.17 |
| *Ankistrodesmus* | 4.28 | 2.33 |
| *Volvox* | - | 1.16 |
| *Closterium* | 23.2 | 1.85 |
| *Gonatozygon* | - | 1.42 |
| *Draparnaldia* | - | 9.52 |
| *Micrasterias* | - | 3.52 |
| *Pediastrum* | 0.68 | - |
| *Botryococcus* | 0.6 | - |
| *Scenedesmus* | 2.4 | - |
| *Richterella* | 2.04 | - |
| *Coelastrum* | 1.98 | - |
| *Protococcus* | 2.29 | - |
| *Microspora* | 3.39 | - |
| *Cladophora* | 2.66 | - |
| **Subtotal** | **43.5** | **31.24** |
| BACILLARIOPHYCEAE | | |
| *Cyclotella* | 10.2 | 0.75 |
| *Tabellaria* | - | 3.42 |
| *Melosira* | 6.2 | 5.50 |
| *Diatoma* | - | 11.35 |
| *Eunotia* | - | 3.09 |
| *Gonatozygon* | 0.5 | - |
| *Mesotaenium* | 2.8 | - |
| *Nitzchia* | 0.7 | - |
| *Synedra* | 0.99 | - |
| *Campylodiscus* | 0.26 | - |
| *Asterionella* | 0.4 | - |
| *Spirotaemia* | 0.36 | - |
| *Pleutotaemia* | 0.05 | - |
| **Subtotal** | **22.25** | **24.1** |

### Phytoplankton

Twenty-one algal taxa were identified in the phytoplankton of Asejire Lake and they belonged to Chlorophyceae (8), Cyanophyceae (8) and Bacillariophyceae (5). Chlorophyceae contributed 31%, Cyanophyceae, 42% and Bacillariophyceae, 27% to the total number of taxa. The dominant taxa were *Draparnaldia, Spirogyra* and *Ulothrix* (Chlorophyceae); *Rivularia*, *Spirulina*, *Microcystis* and *Anabaena* (Cyanophyceae); *Diatoma* and *Melosira* (Bacillariophyceae) **Table 4**. Twenty-seven genera of phytoplankton that composed of Bacillariophyceae (10); Chlorophyceae (10) and Cyanophyceae (7) were recorded in the Eleyele Lake. Chlorophyceae,

Cyanophyceae and Bacillariophyceae accounted for 43.5%, 34.2% and 22.3% of the phytoplankton community, respectively. The dominant taxa were *Closterium* and *Ankistrodesmus* (Chlorophyceae); *Polycystis*, *Merismopedia* and *Tetrapedia* (Cyanophyceae) and *Cyclotella* and *Melosira* (Bacillariophyceae) **Table 6**.

### Diversity Index

The Shannon-Weiner diversity index (H= 0.78) and Margalef index (d = 8.87) for Eleyele Lake were higher than Asejire Lake (H= 0.72; d= 8.02) **Fig. 1**.

## DISCUSSION

The values obtained for phosphorus concentration in both studied lakes were above the typical lake total phosphorus concentration of 10 – 40μg/L (Snoeyink and Jenkins 1980). This high concentration of phosphorus (known to act as a limiting factor to biological productivity in aquatic habitat) could be due to input from various human activities including farming, deforestation, food processing and washing/bathing taking place in the catchment areas. The phosphorus and nitrogen concentration in Asejire Lake being more than double that in Eleyele Lake may have resulted from more

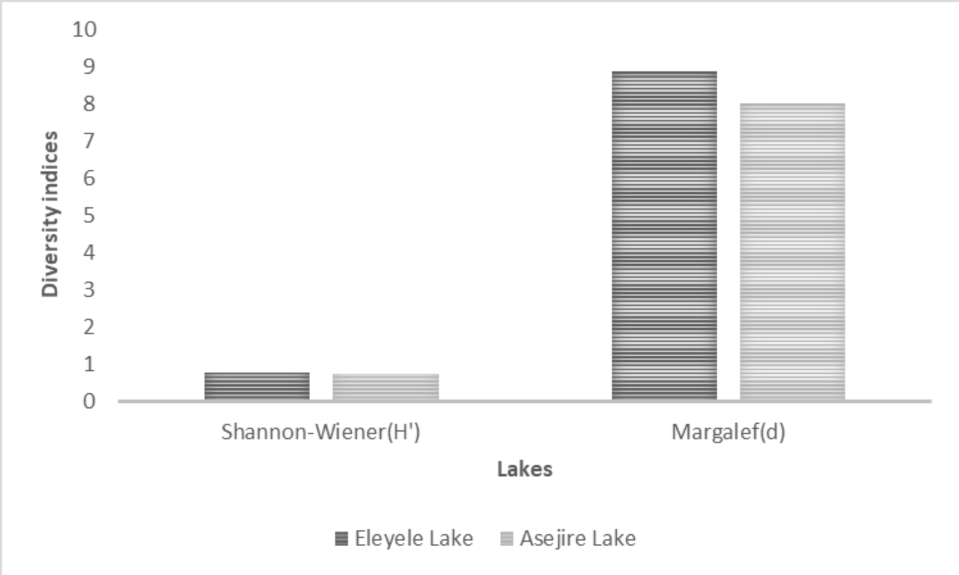


**Fig. 1.** Phytoplankton diversity indices in Eleyele and Asejire Lakes

farming activities in its catchment area and consequently the use of more fertilizers. The concentration of nitrogen in both lakes being lower than phosphorus is contrary to some previous researches like Ekatierynczuk-rudczyk *et al*. (2012) and Martinet *et al*. (2016). Nitrogen differs from phosphorous in that it does not readily sorb to soil particles, it exists in the atmosphere and may be removed from the aquatic ecosystem through denitrification (Chapra 1997). Nitrogen or P limitation of algal growth is a product of the TN and TP concentration and the TN: TP ratio and not of whether the system of study is marine or freshwater (Guildford and Hecky 2000). Fresh waters where the TN/TP ratio is greater than 7, phosphorus will be the limiting nutrient, whereas for TN/TP ratios below 7, nitrogen will be the limiting nutrient for algal growth [Meybeck *et al*. (1989) and Chapman (1996) cited by Galvez-Cloutier and Sanchez (2007)]. Hence, nitrogen is the limiting factor for growth of algae in both lakes. Nitrogen limitation in lakes water could arise from application of fertilizer with more P than N (e.g. 10:43:0 as N:P: K) to farmland in catchment areas. Often TN/TP ratios are low in eutrophic lakes and high in mesotrophic and oligotrophic (Galvez-Cloutier and Sanchez 2007). Eutrophic lakes can have low TN:TP compared to lakes in watersheds with natural land cover, although ratios depend on the type of agriculture (Downing and McCauley 1992). This suggests advanced degradation (eutrophic) condition of these water bodies. While lakes in regions with large-scale animal agriculture can have low TN:TP, lakes in regions dominated by row-crops commonly have high TN:TP (Arbuckle and Downing 2001). However, large - scale animal agriculture does not occur in the catchment area of Eleyele Lake but in Asejire Lake, a large fish farm is in operation.

The significant positive correlation between transparency and chlorophyll a in Lake Asejire is like that obtained by Carlson, 1977 (r= 0.93). This show that transparency was a better indicator of algal biomass in Asejire Lake and chlorophyll a was the major light attenuating substance. In Eleyele Lake, the low correlation between chlorophyll a and transparency and total phosphorus indicates that both parameters were not the most important factor in limiting chlorophyll a concentration. However, the higher correlation of chlorophyll a with total nitrogen (r= 0.50) suggests that nitrogen is the most important factor limiting chlorophyll a concentration (this supports the deduction from the TN:TP). Based on Carlson TSI estimates (Carlson, 1977), Asejire and Eleyele Lakes were in hypereutrophic condition. Also, the trophic levels of the Asejire (118.4) and Eleyele (101.5) Lakes determined by utilization of total-N value categorized the lakes as hypereutrophic. This is also confirmed by the OECD (1982), that presented Eleyele Lake as eutrophic-hypereutrophic and Asejire Lake as hypereutrophic. The general classification by Wetzel, 2001 grouped the two lakes as eutrophic-hypereutrophic. These results show the need for prompt action to be taken to control the source of nutrients to these water bodies.

Szelag-Wsasielewska, 2007 states that changes in qualitative composition of phytoplankton can be the initial sign of quantitative modifications of pelagic phytoplankton that occur during increase in trophic state. Thus, the presence of indicators of eutrophic waters e.g. *Scenedesmus* and *Pediastrum* (green algae, 2.4% and 0.68%, respectively) and *Microcystis* (blue green algae, 6.34%) in the studied lakes suggests they are eutrophic. Members of the Cyanophyceae that dominated the phytoplankton community of Asejire Lake often form nuisance blooms and are known to deteriorate the aquatic environments. *Rivularia* and *Anabaena* are filamentous and contain specialized cells (heterocysts) that develop in response to lack of combined nitrogen sources in the environment. Wetzel (2001); Munawar and Fitzpatrick (2018) stated that nitrogen- limited lake water could favor such nitrogen-fixing(diazotrophic) blue-green algae, which could account for their abundance in Eleyele Lake due to the low TN:TP ratio. *Microcystis*, *Rivularia*, and *Anabaena* produce microcystins that have been implicated in accidental human and animal poisoning. *Draparnaldia, Spirogyra* and *Ulothrix* are filamentous green algae which may be of little benefit to the food chain because of not being feasible food source for filter feeding zooplankton that dominate zooplankton community (Justus, 2005). The dominance of blue- green algae filaments and green algae further suggests that Asejire Lake may be eutrophic (Reynolds, 1984). Also, the abundance of filamentous algae among the phytoplankton community agreed with Carlson (1983) that inferred that the deviation observed between the trophic indices is due to domination by large particulates, such as *Aphanizomenon* flakes. The dominant blue-green algae in Eleyele Lake, *Polycystis* is a free-floating colonial blue-green alga often forming netted or irregular masses and frequently causing water bloom. Meyer *et al*. (1969) reported cattle poisoning related to *Polycystis aeruginosa* in Arkansas. The abundant small *Cyclotella* species provide food for the grazing zooplankton. The Shannon Wiener diversity index for both lakes being below 1 suggests that both are heavily polluted based on classification by Wilhm (1975). Contamination of water lead to being less suitable for growth and survival of organisms except the tolerant species, thus reducing diversity. Thus, the diversity should decrease from oligotrophy to eutrophy, however Rakocevic-Nedovic and Hollert (2005) stated that indices of diversity based on phytoplankton are weak indicators of trophic status of Lake Skadar.

## CONCLUSIONS

Asejire and Eleyele Lakes were in hypereutrophic condition and nitrogen is the limiting factor to algal growth in both lakes. Taxa that form bloom and produce toxins (including *Microcystis, Rivularia* and *Polycystis*) were encountered in the studied lakes. Future management strategies in these lakes should include manual cleaning of biomass and clearing of macrophytes to increase water transparency and reduction of phosphate load is required. Long-term monitoring, inclusion of zooplankton composition and abundance are required for recovery of these eutrophic lakes.

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