Monitoring of Phytoplankton in the Artificial Lake: Comparison Study

Z J Kadeem¹, F M Hassan¹, A H M J Al Obaidy²
¹Department of Biology, College of Sciences for Woman, University of Baghdad
²Environment Research Center (ERC)-University of Technology (UOT)
Email: zainab.jawad1102a@csw.uobaghdad.edu.iq

Abstract. The current study was carried out to study phytoplankton in Lake of Baghdad Touristic Island from July 2019 to February 2020 to predict the Lake's environmental change. Monthly samples were taken from the surface water from four sampling sites in the Lake and the results were presented as dry and wet seasons. A total of 180 algal taxa was identified with the dominancy of diatoms. The highest total cell number of phytoplankton was recorded at the fourth site with 303.85×10⁴ cells/L in dry season 2019, while the lowest was 93.72× 10⁴ cell/L in the third site during the dry season 2019. The diatoms dominancy is still higher than 90%, while the Cyclotella spp percentage reduced from 90% to less than 5% in this study. Achananthes spp percentage became raised >7% in comparison with a previous study in 1989. These results showed the dominancy of diatoms among other algal taxa. They reduced the total number of Chlorophyceae and Cyanophyceace in the Lake, which indicates the stability of environmental conditions and good lake management.

Keywords: Phytoplankton, Diatom, Artificial Lake, Comparison study.

1. Introduction
The aquatic system of freshwater is the primary source of most life for aquatic organisms [1]. Phytoplankton is considered a fundamental component of the aquatic food chain. It is a source of oxygen and major organic compounds of all forms of water bodies. They are initial biological elements from which energy is passed across the food chain to the higher organisms [2, 4, 5]. Phytoplankton has a significant role in the nutrient cycle and plays an essential role in maintaining a balance between living organisms and abiotic factors [4]. Phytoplankton is an important and significant organism that functions in any aquatic environment as a primary food supply provider. This organism plays the main role in solving different environmental problems, producing a useful substance to understand the aquatic environment [5]. Many researchers mentioned the importance of phytoplankton as a bioindicator in various aquatic ecosystems [6, 7]. Because of their life characteristics, such as fast reproduction and short times of generation, the phytoplankton is considered a useful bioindicator and a warning agent in aquatic environments. It can adapt to environmental changes [8, 9].

Phytoplankton is used in many studies to indicate environmental status. Adedeji et al. [10] studied the comparison of two lakes (Fort and Wadr al Lakes) in Nigeria. The species composition of plankton and environmental factor found the Fort lake change in eutrophication status. In contrast, another lake was less polluted.

Banu et al. [11] found that the Uzuncayır Dam Lake (Turkey) signs moderately of organic pollution according to their study on phytoplankton. Snmez et al. [12] emphasize the importance of studying the ecological parameter with the biological components of aquatic systems (such as phytoplankton).

This study aims to compare the results of the current study with previous studies conducted in the same study area to predict the effect of environmental changes.
2. Material and Methods

2.1. Study area
Baghdad Touristic Island Lake is one of the most famous tourist attractions in Iraq. It is an artificial water body located within the Baghdad Tourist Island in Al-Fahhama area north of Baghdad city (Figure 1). The Lake is located in the right part of the tourist island. It is necessary to monitor the water quality because of Lake exposure to pollution by tourists. The first site represented Tigris River and the inlet of water to the Lake, the second site located at the northern side of the Lake, the third site located in the tower area in the middle of the Lake, and the fourth site on the southern side of the Lake.

![Figure 1. Sampling stations in Baghdad Touristic Island Lake, Baghdad-Iraq](image)

2.2. Sample collection
Phytoplankton samples were collected monthly, from four sites in the study area (Table 1) from July 2019 to February 2020 and represented as dry and wet seasons. The quality of phytoplankton was estimated depending on APHA [13], taken a 1L of each sample and preserved by a Lugol’s solution (1:100) ml in a Duran cylinder of a 1L then left to settle for (10-15) days and concentrated the sample to 100 ml finally repeated the process to reach (10 ml). A light microscope was used to identify phytoplankton species (with a power of magnification 400×1000 x). The permanent slides were prepared using a concentrated nitric acid, for diatoms clarification, then classified by utilizing permanent slides [14]. The method of the micro- transect was utilized for counting of diatoms(100x). Algal species were identified according to [15], while non-diatom algae were diagnosed by preparing temporary slides and examined at (40x), according to Furet and Benson-Evans [16].

| site | Longitude(eastwards) | Latitude(northwards) |
|------|----------------------|----------------------|
| S1   | 44° 19’47.4          | 33° 22’36.6          |
| S2   | 44° 20’32.4          | 33° 46’39.6          |
| S3   | 44° 09’25.2          | 33° 12’247           |
| S4   | 44° 19’47.4          | 33° 22’366           |

3. Results and Discussion
Phytoplankton considers an essential primary production in the natural waters [17] and the study of their community structure is important for monitoring aquatic ecosystems [11,18].
A total of 180 algal taxa was identified in the Lake (Table 2). The algal composition consisted of Bacillariophyceae (three classes), Chlorophyceae, Cyanophyceae, Zygnematophyceae, Pyrrhophyceae, Cryptophyceae Euglenophyceae, and Chrysophyceae. The results of the present study showed that the total number of phytoplankton in the Lake recorded the maximum value ($305 \times 10^4$ cell/L) of phytoplankton was observed in the dry season at Tigris River observe. In contrast, its value was $229 \times 10^4$ cell/L in the studied Lake. This increase responds to the impact of the environmental factors such as the length of daylight, the intensity of lighting, temperature values and decomposition activities [16,17]. The minimum value at River and Lake was $147 \times 10^4$ cell/L, $95 \times 10^4$ cell/L, respectively, in wet and dry seasons. Ismail [20] noticed these results, while other studies [21,23] noticed the increase during the wet season.

The dominance of diatoms in Iraq’s inland water ecosystems is considered a common phenomenon [22]. This diatoms ability comes from its life and resistance to the different environmental conditions, besides to the availability of silica in the Iraqi water, which the diatoms use in their frustule structure [25], for that the diatoms existed throughout the study period and formed the majority of the total number of all stations.

The dominant group of River’s phytoplankton was the Bacillariophyceae, that represented by $182 \times 10^4$ cell/L (80%), also noticed that dominance in the results of the sites in the Lake, which recorded $273 \times 10^4$ cell/L (78%), that dominance due to its rapid response to changes in physical, chemical and biological factors in the aquatic ecosystem, as well as a great capacity for growth and reproduction in the presence of various environmental variations such as high temperature, the intensity of light, salinity and plant nutrients [26, 27] and that capacity to resistance change environmental conditions its possession of a siliceous wall [28]. Bacillariophyceae dominance is identical to previous studies conducted on the Tigris River and Lake [17-20]. Some diatoms recorded the highest number throughout the present study and other previous studies conducted on the Tigris River and Baghdad Touristic Island, as shown in Table 3.

### Table 2: The Total number and percentage of phytoplankton in the present study

| Classes          | S1    | S2    | S3    | S4    |
|------------------|-------|-------|-------|-------|
|                  | Dry   | Wet   | Dry   | Wet   | Dry   | Wet   | Dry   | Wet   | Dry   | Wet   |
| Bacillariophyceae| 182   | 80    | 109   | 75    | 106   | 73    | 66    | 71    | 117   | 73    |
| Fragillariophyceae| 13    | 6     | 12    | 8     | 8     | 4     | 3     | 5     | 10    | 6     |
| Coscidiscophyceae| 25    | 11    | 8     | 6     | 6     | 10    | 7     | 11    | 12    | 6     |
| Cyanophyceae     | 2     | 1     | 5     | 4     | 4     | 6     | 4     | 4     | 5     | 3     |
| Chlorophyceae    | 4     | 2     | 8     | 5     | 5     | 15    | 11    | 4     | 5     | 17    |
| Euglenophyceae   | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     |
| Pyrrhophyceae    | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     |
| Dinophyceae      | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     |
| Cryptophyceae    | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     |
| Chrysophyceae    | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     |
| Zygnematophyceae | 1     | 1     |       |       |       |       |       |       |       |       |
| Total            | 229   | 100   | 147   | 100   | 103   | 100   | 146   | 100   | 95    | 100   |

Table 2: The Total number and percentage of phytoplankton in the present study
Table 3. The highest number of genera (comparison) of diatoms recorded in the Tigris River and Baghdad Touristic Island of the present study and previous studies.

| Present study          | The previous study (17-20)         |
|------------------------|-----------------------------------|
| High Achnathidium      | Cyclotella                        |
| Amphora                | Anomoeoneis                       |
| Cocconeis              | Meloseira                         |
| Cyclotella             | Diplosa                          |
| Cymatotopleura         | Cymbella                          |
| Gomphonema             | Achnanthes                        |
| Lemnicola              | Nitzchia                          |
| Ulnaria                | Navicula                          |
| Melosira               | Cymbella                          |
| Navicula               | Gomphonema                        |
| Low                    | Synedra                           |

Cosinodiscophyceae group followed by Bacillariophyceae and was recorded $11 \times 10^4 \text{cell/L} (12\%)$ in the Lake and $25 \times 10^4 \text{cell/L} (11\%)$ in the River. This study showed that the pinnate diatoms (Bacillariophyceae) were dominated on the central diatom (Cosinodiscophyceae). The species Aulacoirea Italica that related to Coscinodiscophyceae recorded in the River $14.11 \times 10^4 \text{cell/L} (6.23\%)$, While the species A. granulata recorded $14.95 \times 10^4 \text{cell/L} (6.57\%)$ and these results were agreed with other previous studies (17-20). When the pinnate diatoms (Bacillariophyceae) dominate on the central diatoms (Cosinodiscophyceae), that indicated water healthy, while the dominance centric diatoms evidence disturbances in the surface of the water [29, 30]. Fragillariophyceae was represented 8\% ($12 \times 10^4 \text{cell/L}$) at River and 7\% ($11 \times 10^4 \text{cell/L}$) in the Lake.

Chlorophyceae was the dominant group after Coscinodiscophyceae by recording $17 \times 10^4 \text{cell/L} (11\%)$ in the Lake, while its value in the Tigris River was $8 \times 10^4 \text{cell/L} (5\%)$ also these results noticed by [20]. While in Ismail Study [20], it presents more than 20\%. The percent of Cyanophyceae reduced from 15.2\% (20) to 4\% in the present study. Cyanophyceae was recorded $5 \times 10^4 \text{cell/L}$ in the River and $4 \times 10^4 \text{cell/L} (5\%)$ in the Lake. The reduction in the total number of Chlorophyceae and Cyanophyceae in the Lake is indicated to the alteration in the trophic status of the Lake that is related the lake management. Another group, such as Pyrrhophyceae, was recorded $1 \times 10^4 \text{cell/L} (1\%)$ in the River and $3 \times 10^4 \text{cell/L} (2\%)$ in the Lake. Dinophyceae, Cryptophyceae and Zygnematophyceae were noticed in the Lake only. The phytoplanktonic groups Pyrrophyceae, Cryptophyceae Euglenophyceae, Chrysophyceae found in the Lake and River but with a low value as shown in Table 2.

Some phytoplankton species were characterized by their presence in most dry and wet seasons, such as A. pediculus, Craticula cuspidate, Staurosira construens, Cosinodiscus spp, C. botrytis, Phacus caudatus and Ceratium hirundinella (Figure 2). There is a difference between the percentage of phytoplankton classes recorded in the present study and the previous study [20], as shown in Figures 3 and 4.

In comparing identified taxa with a previous study in 1989, noticed the presence and absence of some of them (Table 4).
Figure 2: dominance phytoplanktonic species in the present study

Figure 3: The percentage of phytoplanktonic classes in Baghdad Touristic Island Lake and Tigris River 1989

Figure 4: The percentage of phytoplanktonic classes in Baghdad Touristic Island Lake 2020
Table 4: Taxa in Tigris River and Baghdad Touristic Island Lake through present study 2020 and previous study in 1989

| Taxa           | Present study | A previous study in 1989 |
|----------------|---------------|--------------------------|
| *Tabellaria*   | -             | +                        |
| *Asterionella* | -             | +                        |
| *Stephanodiscus* | -            | +                        |
| *Anomoeis*     | +             | +                        |
| *Cyclotella*   | +             | +                        |
| *Melosira*     | +             | +                        |

4. Conclusion

The phytoplankton species composition indicated the environmental change and observed the balance toward the Bacillariophyceae among other algal groups. The dominance of pinnate diatoms is indicated to the stability of environmental and good lake management. It noticed that the Chlorophyceae and Cyanophyceae became reduced in their number and the Lake hasn't forwarded to eutrophic status.

References

[1] Xu M, Wang Z, Duan X and Pan B 2014 Effects of pollution on macroinvertebrates and water quality bio-assessment *Hydrobiologia*, 729:247–59
[2] Tiwari A and Chauhan S V S 2006 Seasonal phytoplanktonic diversity of Kitham lake, Agra J Environ Biol, 27:35-8
[3] Saifullah A S M, Abu Hena M K, Idris M H, Halimah A R and Johan I 2014 Diversity of phytoplankton from mangrove estuaries of Sarawak, Malaysia, *World Appl. Sci. J.*, 31:915–924
[4] Wetzel R. G. 2001 *Limnology: lake and river ecosystems.* (gulf professional publishing)
[5] Kurano N and Miyachi S 2004 Microalgal studies for the 21st Century. *Hydrobiologia*, 512:27–32
[6] Aziz F H 2009 Algae assemblages as biological indicators for freshwater quality assessment, *J. Univ. Duhok, Pure Eng. Sci.*, 12:15–20.
[7] Bellinger E G and Sigee D C A 2010 key to the more frequently occurring freshwater algae. *Freshw. Algae*, pp137–244
[8] Chaturvedi R K, Sharma K P, Sharma K, Bhardwaj S M and Sharma S 1999 Plankton community of polluted waters around Sangeran, Jaipur. *J. Environ. Pollut.*, 6:77–84
[9] Sheikhar T R S, Kiran B R, Puttaiaah E T, Shivaraj Y and Mahadevan K M 2008 Phytoplankton as index of water quality with reference to industrial pollution, *J. Environ. Biol.*, 29:233
[10] Adeleji A A, Adesakin T A and Bolawa O P 2020 Assessment of the Ecological Status of OPA Reservoir, ILE IFE, Nigeria Based on a Comparative Study of its Phytoplankton Community and Water Quality Parameters. *Open Acad. J. Adv. Sci. Technol.*, 4:1–14
[11] Kutlu B, Aydın R, Danabas D and Serdar O 2020 Temporal and seasonal variations in phytoplankton community structure in Uzuncayır Dam Lake (Tunceli, Turkey). *Environ. Monit. Assess.*, 192:1–12
[12] Sonmez F, Kocer M A T, Alp M T and Sen B A 2018 study on occurrence of algae in a stream heavily polluted with household wastewater, *Fresenius Environ. Bull.*, 27:7863–71
[13] Baird R B, Eaton A D and Eugene W 2017 *Standard Methods for the Examination of Water and Wastewater*, 23rd Edition.
[14] Salman J M, Hassan F M and Baiee M A 2017 Practical Methods in Environmental and Pollution Laboratory. *Natl. Libr. Baghdad*, 120.
[15] Round F E, Crawford R M and Mann D G 1990 The diatoms biology, and morphology of the genera. Cambridge University Press, pp125-129.
[16] Furet J E and Benson-Evans K 1982 An evaluation of the time required to obtain complete sedimentation of fixed algal particles prior to enumeration, *Br. Phycol. J.*, 17:253–8.

[17] Reynolds C S 2006 *The ecology of phytoplankton*. Cambridge University Press.

[18] Hulyal S B and Kaliwal B B 2009 Dynamics of phytoplankton in relation to physico-chemical factors of Almatti reservoir of Bijapur District, Karnataka State, *Environ. Monit. Assess.*, 153:45–59

[19] Peterson C G and Stevenson R J 1989 Seasonality in river phytoplankton: multivariate analyses of data from the Ohio River and six Kentucky tributaries. *Hydrobiologia* 182:99–114.

[20] Ismail A M 1989 Ecological and comparative study between Baghdad Touristic Island Lake and Tigris River within Baghdad.

[21] AL-JANABI Z Z F 2001 Application of Water Quality Indices for Tigris River within Baghdad city- Iraq.

[22] Jabar M A A 1997 Ecological Study on Aladaim River and its effect on Tigris River.

[23] Al-Sarraf M A-A A 2006 Ecological and Taxanomical Study for Phytoplankton in Al-Adaim and Diyala Tributaries and their Effects on Tigris River.

[24] Al-Jibouri K D W, Hassan F M and Hakman A A 2018 Ecological and taxonomical study of epipelion community in Diyala River in Diyala province-Iraq. *Indian J. Ecol.*, 45:680–8.

[25] Letáková M., Fránková M. and Pouličková A. 2018 Ecology and applications of freshwater epiphytic diatoms. *Cryptogam. Algol.*, 39:3–22

[26] Mukai H. 2006 Contribution of benthic and epiphytic diatoms to clam and oyster production in the Akkeshi-ko estuary. *J. Oceanogr.*, 62:267–281

[27] Hassan F M, Salman J M, Alkam F A and Jawad H J 2014 Ecological observations on epipelic algae in Euphrates river at Hindiya and Manathira, Iraq. *Int. J. Adv. Res.*, 2:1183–94.

[28] Leelahakriengkrai P and Peerapornpisal Y 2010 Diversity of Benthic diatoms and water quality of the Ping river, Northern Thailand. *Environ. Asia*, 3:82–94.

[29] Kane D D 2004 The development of a planktonic index of biotic integrity for Lake Erie.

[30] Darweesh S F A 2017 Water Quality Assessment of Tigris River by Diatoms Community between Al-Aziziyah and Kut/Iraq.