Water Quality and phytoplankton communities in Orfaily Drain, Minia, Egypt

Basha O. R.[1], Fathi A. A.[1*], Zakaria A. Mohamed[2] and Shoulkamy M. A.[1]

[1]*Department of Botany and Microbiology, Faculty of Science, Minia University, Minia, Egypt.*

[2]*Department of Botany and Microbiology, Faculty of Science, Sohag University, Sohag, Egypt.*

Abstract:

Biodiversity is one of the important biological factors in determining water quality and preserving the ecological balance. One of the main drainage systems in Minia is the Orfaily Drain. In this study, variations in both the physico-chemical characteristics and the phytoplankton of Orfaily Drain were monitored over a period of one year (from May 2022 to April 2023). All the water quality variables measured showed considerable monthly variations. Marked seasonal quantitative and qualitative differences occurred in the phytoplankton communities of the drain. The maximum crop density (3676 x 10^5 taxa l^{-1}) was obtained in June 2022, while the lowest count (512 x 10^5 taxa l^{-1}) occurred in December 2022. Changes in total algal counts throughout the investigation coincided closely with abundance of Chlorophyceae and Cyanophyceae. The major algal groups at this site were Chlorophyceae, Cyanophyceae, Bacillariophyceae, and Euglenophyceae. Fourty two genera were found, including 17 genera of Chlorophycae, 12 of Bacillariophycae, 11 of Cyanophycae, and 2 of Euglenophycae. *Cyclotella meneghiniana*, *Navicula* sp., *Scenedesmus bijuga* and *Chroococcus turgidus* were recorded in a high rank of occurrence, however other recorded species were be found to moderately, frequently or rarely recovered. In general, the species data indicate that the Orfaily Drain water can be categorized as eutrophic. It was concluded that the phytoplankton groups are very sensitive and helpful indicators to measure the quality of freshwater ecosystems and the health state of any water stream.

Keywords: Orfaily Drain; phytoplankton communities; Water Quality.

Introduction

Most aquatic organisms depend on aquatic habitats for their primary source of life support **(Toma and Aziz 2022)**. In Egypt, the River Nile is considered a main supply of water for drinking, agriculture, and manufacturing. When found suitable, drainage water may be employed for agriculture (**Abdelsalam *et al.*, 2020**). The biological life of these water sources may be

*Corresponding author: email: adel.fathi@mu.edu.eg (ISSN: 1110-8649)

impacted by contamination from the outside **(Badr El-Din *et al.*, 2015)**. Since biological communities incorporate the environmental impacts of river and lake water chemistry, biological evaluation is important in assessing the overall health of aquatic ecosystems **(Stevenson and Pan 1999)**. Agriculture in Egypt has actually benefited much from the numerous irrigation and drainage canals which obtain the water from the Nile (**Radwan *et al.*, 2004**). In an aquatic ecosystem, phytoplankton is the main producer and a key source of nutrients as they interact with the biogeochemical cycles of various elements to provide heterotrophic microorganisms with organic matter **(Jaffer *et al.*, 2023)**. According to **Djumanto *et al.* (2020)**, phytoplankton availability accounts for 40% of primary production worldwide and forms the basis of the aquatic food chain. Distribution and abundance of phytoplankton populations, which are indicators of water quality, have been impacted by alterations in hydro-climatic, biological, and chemical components of the aquatic ecosystem. **(Bergstrom *et al.*, 2020; Inyang and Wang 2020)**.

Initial studies of Egypt's drainage and irrigation waters primarily investigated their suitability for irrigation (**Al-Shami *et al.*, 2010**; **Badr El-Din *et al.*, 2015; Abdelsalam *et al.*, 2020; Ahmed and Mahran 2022; El Hadry *et al.*, 2022; Al-Afify *et al.*, 2023**). Accordingly, this study will be conducted Orfaily Drain to present the findings of a routine sample of water quality and phytoplankton diversity done seasonally over the period of a year, which could be a first.

Materials and Methods

Site description:

The drainage type of the Orfaliy drainage canal is an agricultural drainage, and it is one of the subsidiary drainage systems in the Minia district. It is about 4320 km long and serves about 2700 acres, discharging its water at the El-Mohit drain and receiving water from the Damshir drain (Figure 1).

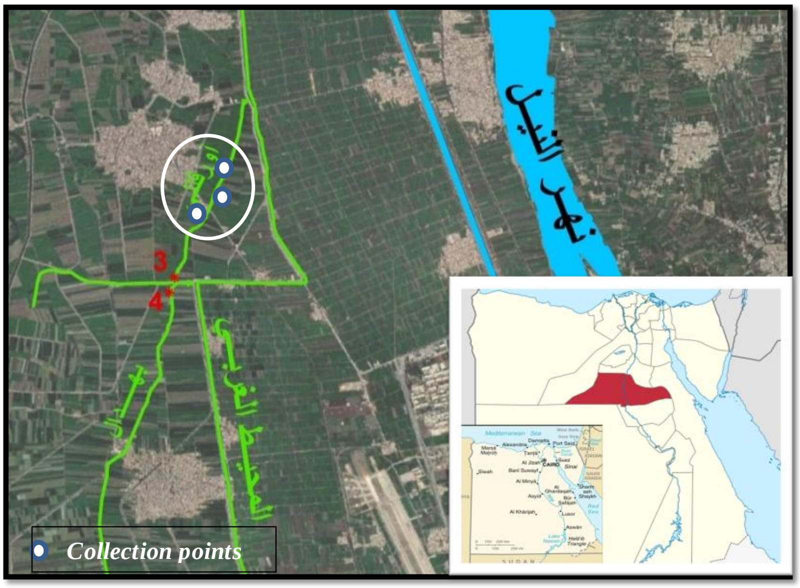

Fig.1. Map showing the sampling site.

Sampling and Physico-chemical characteristics:

Over a year (May 2022 to April 2023), the drain was monitor on a regular basis. Monthly water surface samples were taken from different points inside the drain. The locations were chosen to provide an accurate spatial representation of the water quality. Temperature, pH, conductivity, total dissolved salts and Dissolved oxygen of the lake water were measured at each location. pH was measured using a pH meter (Adwa, AD110; Romania), conductivity and total dissolved salts using a calibrated Conductivity Meter (Adwa, AD 310; Romania). Dissolved oxygen was measured according to the Winkler method (**Strickland and Parsons 1972**). According to **Adams (1991)**, measurements of total alkalinity, phosphate-P, nitrate-N, chloride, silicate, and main cations were made in the drain water samples. According to **Golterman and Clymo (1971)**, sodium and potassium concentrations were measured photometrically by flame emission. The findings are calculated as the means of measurements done in triplicate on each water sample.

Quantitative and qualitative analysis of phytoplankton:

A liter of samples of water were fixed on the situ with acidified Lugol's solution for phytoplankton examination. At least 36 hours were given for samples to settle in the lab before the excess supernatant was carefully eliminated and the remaining fluid was adjusted to a constant level. Until analysis, this material was stored at 4 °C. Following the Utermöhl method **(Utermöhl, 1958)**, phytoplankton counts were conducted using a phase contrast Carl Zeiss (Jena Med2) microscope at 100x and 40x magnification. The simplified techniques outlined in **Willen (1976)** and **Hobro and Willen (1977)** for algal counts were used. Cells per liter were used to express counts of phytoplanktonic algae, whether they were filamentous, colonial, or unicellular. The cell counts were determined using the means of three replicated measurements. The phytoplankton taxa were categorized in accordance with authorized references, such as **Smith (1950)**, **Bourrelly (1981)**, **Komarek and Fott (1983)** and **Prescott (1987)**. Indices of biodiversity like Margalef's Index (D) and Simpson's Diversity Index (1-H) were used for quantitative analysis of species diversity.

Results and Discussion

Environmental aspects including climate, chemistry, and pollution are frequently linked to the biotic variables used to describe various freshwater habitats **(Krishnan 2008)**. The species composition and distribution of the algae are significantly influenced by the physicochemical properties and nutritional content of water (**McCormick and Cairns 1994**; **Abdelsalam *et al.*, 2020**; **Ahmed and Mahran, 2022**; **El Hadry *et al.*, 2022**; **Al-Afify *et al.*, 2023**).

The water samples of this site were collected from Orfaliy drain. Table (1) shows the physico-chemical properties of the studied drain water. The monthly water temperature of Orfaliy drain reached a maximum in July 2022 (31.6 ºC) and the minimum value (16.9 ºC) was recorded in December 2022. In the current study, water analysis revealed a large temperature range. Due to their shallow depth and sizable surface area in comparison to their volume, the studied drains' water temperatures often tracked those of the surrounding air (**Fathi *et al.*, 2001; Adam *et al.*, 2013**).

Table.1. Physico-Chemical characteristic of water sample collected from Orfaliy drain during the investigation period.

Year/month	2022								2023			
Parameters	M	J	J	A	S	O	N	D	J	F	M	A
Temp. (^0C)	23.2	27.7	31.6	27.9	28.6	24.4	17.6	16.9	20.1	21	19.7	22.1
pH	8.49	8.20	8.14	8.70	8.29	8.08	8.26	8.59	7.62	8.04	8.14	9.28
Conductivity (µS/cm)	690	729	644	832	701	1147	1012	1400	859	797	726	822
T.D.S. (mgl^{-1})	441.6	466.56	412.16	532.48	448.64	734.08	647.68	896	549.76	510.08	464.64	526.08
Dissolved O_2 (mgl^{-1})	6.94	5.63	5.13	4.11	5.12	5.04	3.33	4.53	3.2	3.9	8.77	8.87
Total alkalinity (mgl^{-1})	140.0 ± 0.0	144.0 ± 0.0	142.0 ± 0.0	122.0 ± 0.0	136.6 ± 0.6	107.3 ± 0.6	85.0 ± 0.0	75 ± 0.0	34.0 ± 0.0	26.0 ± 0.0	80.0 ± 0.0	120.0 ± 0.0
Chloride (mgl^{-1})	28.53 ± 0.2	20.8 ± 0.0	32.27 ± 0.2	25.6 ± 0.12	32 ± 0.0	54.67 ± 0.2	28 ± 0.0	55.2 ± 0.2	51.2 ± 0.24	21.6 ± 0.21	19.2 ± 0.0	23.2 ± 0.0
Nitrate (mgl^{-1})	0.43 ± 0.01	2.65 ± 0.0	0.08 ± 0.0	3.51 ± 0.0	5.41 ± 0.02	1.29 ± 0.01	5.60 ± 0.0	3.84 ± 0.0	1.22 ± 0.01	0.48 ± 0.0	1.10 ± 0.0	0.23 ± 0.0
Phosphate (mgl^{-1})	0.11 ± 0.01	0.87 ± 0.02	5.19 ± 0.04	2.78 ± 0.01	0.46 ± 0.01	0.03 ± 0.01	0.55 ± 0.25	0.84 ± 0.0	0.05 ± 0.09	0.04 ± 0.01	0.08 ± 0.01	0.04 ± 0.03
Silicate (μgl^{-1})	26.34 ± 0.1	21.31 ± 0.2	23.34 ± 0.0	24.70 ± 0.1	25.91 ± 0.0	37.8 ± 0.14	52.22 ± 0.2	63.6 ± 0.1	75.0 ± 0.22	83.58 ± 0.2	65.6 ± 0.08	52.1 ± 0.01
Calcium (mgl^{-1})	27.3 ± 0.13	25.6 ± 0.12	19.33 ± 0.1	25.2 ± 0.0	35.47 ± 0.1	76.13 ± 0.1	67.47 ± 0.1	61.2 ± 0.1	54.4 ± 0.0	19.6 ± 0.0	15.2 ± 0.12	26.8 ± 0.0
Magnesium (mgl^{-1})	15.28 ± 0.0	18.24 ± 0.0	13.4 ± 0.08	12.96 ± 0.0	18.96 ± 0.1	28.96 ± 0.0	24.32 ± 0.0	43.2 ± 0.0	6.48 ± 0.12	24.24 ± 0.0	10.08 ± 0.0	15.84 ± 0.1
Potassium (mgl^{-1})	65.18 ± 0.0	75.0 ± 0.0	52.17 ± 0.0	77.0 ± 0.0	80.3 ± 0.0	77.61 ± 0.0	120 ± 0.0	85.8 ± 0.0	68.78 ± 0.0	14.65 ± 0.0	81.17 ± 0.0	91.39 ± 0.0
Sodium (mgl^{-1})	122.7 ± 0.0	123.9 ± 0.0	122.2 ± 0.0	280.3 ± 0.0	381.3 ± 0.0	343.4 ± 0.0	310.6 ± 0.0	135. ± 0.0	147.7 ± 0.0	100.5 ± 0.0	137.6 ± 0.0	183.3 ± 0.0

pH is one of the most significant chemical aspects of all waters, which discuss several significant biotic and abiotic ecological features of aquatic systems overall. The pH of the site under investigation was consistently alkaline and ranged from 7.11 to 9.28. This overall trend toward alkalinity may be due to the rising photosynthetic activity seen in phytoplankton and autotrophs, which was also previously reported **(Adams *et al.*, 2013; Abdelsalam *et al.*, 2020)**. **Kataria *et. al.* (1995)**, concluded that the basic indicator used to determine whether water is suitable for farming purposes is electric conductivity. Additionally, they have a significant impact on the aquatic biota. In the current investigation the TDS and EC were found to be high in winter months, while the lowest TDS and EC was discovered to have fluctuated in other months, but only slightly. On the one hand, differences in TDS may be related to the salt that algae and other merged plants consume, the rate of evaporation, the size of the water body, and the input of water **(Lashari *et. al*., 2009)**. **Al-Shami *et al.* (2010)** indicate that the use of fertilizers and pesticides extremely alters the ion concentration of the water as well as its chemical properties. Aquatic life and environmental changes depend significantly on the amount of dissolved oxygen (DO) present. In general, the summertime brought higher dissolved oxygen levels to the Orfaliy drain water than the wintertime. Dissolved oxygen is being used to gauge river freshness and the cleanliness of the water. However, a reduction in oxygen occurs frequently when algal populations consume rapidly. Depletion in DO may be a gauge of high levels of organic matter and nutrient load, according to **Abdelsalam *et al.* (2020)**.

The monthly variations in total alkalinity, nitrate, phosphate, chloride and silicate in the drain water are shown also in Table (1). The ability of water to buffer fluctuations in pH that naturally result from phytoplankton's photosynthetic activity is known as alkalinity, and it is crucial for aquatic life in freshwater systems **(Fathi *et al.*, 2001).** The total alkalinity of drain water fluctuated between

26.0 mg l^{-1} in February 2023 and 144.0 mgl^{-1} in June 2022, increasing in the summer and decreasing in the winter. **Ahmed and Mahran (2022)** observed that the highest average bicarbonate assessments were detected both in the summer and the winter, and that these changes could be ascribed to domestic wastewater that has not undergone treatment. The amount of chloride reached its highest point in concentration in December 2022 (55.2 mg l^{-1}) and its lowest point in March 2023 (19.2 mg l^{-1}).The highest values might be caused by the domestic sewage and agricultural waste that are discharged in it **(Masoud *et al.*, 2001)**. The key nutrients for all algal growth are nitrogen and phosphorus, and the limited availability of both of them in water typically restrict algal growth in natural ecosystems. The data also show that between July 2022 and November 2022, the nitrate value fluctuated from 0.08 mg l^{-1} to 5.6 mgl^{-1}. Though the minimum phosphate levels were 0.30 mgl^{-1} in October 2022 and the maximum was 5.19 mgl^{-1} in July 2022, respectively. As stated by **Krishnan (2008)**, external factors that include cultural influences, fertilization, and flow rate are more closely linked to the accumulation of N and P in the environment. However, phytoplankton's consumption of phosphate might be the main reason of its decline. **(Brown and Austin, 1973).** The Bacillariophyceae depend on silica, as is widely known. Silicate concentrations were found to be fluctuated in an inverse manner, going down in the summer and up in the winter. The largest amount of silicate-Si was measured in February 2023 (83.58 g l^{-1}), while the lowest amount was measured in June 2022 (21.31gl^{-1}). According to several studies (**Fathi *et al.*, 2001; El-Badawy, 2013)**, variations in silicate uptake by diatoms and irrigation water input to the drains under investigation were likely responsible for the observed variations in silicate concentrations.

According to research by **Hussein (1989)**, calcium and magnesium play a specific role in production of phytoplankton. With occasional monthly and seasonal changes, the concentrations of divalent (Ca^{+2} and Mg^{+2}) and monovalent (Na and K) cations were consistently high (see Table 1). The data also show that the monthly ranges for calcium and magnesium were respectively 15.2 - 76.13 mgl^{-1} and 6.48 – 43.2 mgl^{-1}. Sodium concentrations were found to be significantly greater than those of the other cations over the period of the investigation. From 100.5 mg l^{-1} in February 2023 to 381.0 mgl^{-1} in September 2022, sodium varied. Potassium fluctuates more but stays within a range when compared to sodium. **Abdelsalam *et al.* (2020)** reported that calcium ion's adsorption on metallic oxides has an impact on the water's calcium content, and microorganisms play a significant function in the calcium exchange between sediments and subsurface water. Magnesium is typically found in aquatic systems at high concentrations compared to plant requirements and doesn't seem to be a limiting element in the four investigated sites.

A variety of microorganism habitats can be found in the drainage environment. Regarding their needs for availability of nutrients, temperature, water, and light, it provides a suitable environment for the flourishment of diverse groups of algae **(Adams *et al.*, 2013; Abdelsalam *et al.*, 2020).** The results of this site indicate that this site's algal flora exhibits significant monthly changes from other investigated sites in terms of both its quantitative and qualitative composition (Table 2 and Figures 2 and 3). In terms of phytoplankton abundance the maximum count (3676×10^5 taxa l^{-1}) was obtained in June 2022, while the lowest count (512×10^5 taxa l^{-1}) occurred in December 2022. The major algal groups at this site were Chlorophyceae, Cyanophyceae, Bacillariophyceae, and Euglenophyceae (Figure 2). The data of also shows that throughout the whole study period, blue green algae dominated all other groups of algae. Their relative density varied from 27.34% in December 2022 to 90.91% in June 2022.

Table 2. Monthly variation in qualitative and quantitative number of phytoplankton taxa (no. x 10^5 l^{-1}) in Orfaliy drain, during the period of study.

Algal species/ month	2022								2023				Total No.	no. of isolation cases	Rank of occurrence
	M	J	J	A	S	O	N	D	J	F	M	A			
Bacillariophyceae															
Amphora paludosa W.Sm.	0	0	0	0	0	0	0	8	0	0	0	0	12	1	R
Cocconies placentula	0	0	0	0	0	0	0	0	0	0	32	0	32	1	R
Cyclotella meneghiniana Kuetz	60	100	60	80	56	320	0	12	20	0	12	0	720	9	H
Cymbella sp.	0	0	0	0	0	360	0	12	20	0	32	0	424	4	F
Fragilaria capucina Desmaziere	40	0	24	40	0	200	140	60	20	0	0	12	536	8	M
Gomphonema sp.	0	0	0	0	0	0	0	4	0	0	0	0	4	1	R
Gyrosigma acuminatum (Kutz)	0	0	0	0	0	0	0	0	4	0	0	0	4	1	R
Melosira granulata	24	0	0	0	0	0	0	24	32	0	20	0	100	4	F
Navicula sp.	8	28	12	0	36	280	240	80	60	8	0	20	772	10	H
Nitzchia sp.	20	32	4	0	16	0	0	8	0	0	0	4	84	6	M
Pinnularia alpha	28	32	20	0	32	0	0	0	0	0	0	0	112	4	F
Synedra acus Kuetz	12	20	0	0	0	0	0	0	0	0	0	4	36	3	F
Total number	**192**	**212**	**120**	**120**	**140**	**1160**	**380**	**208**	**156**	**8**	**96**	**40**	-	-	-
Clorophyceae															
Ankistrodesmus falacatus corda Ralfs	0	0	8	12	0	0	0	0	0	0	4	0	24	3	F
Chlamydomonas sp.	0	0	0	0	0	0	0	0	40	600	0	0	640	2	R
Chlorella vulgaris (Beyerink)	0	0	0	0	0	0	0	0	120	0	0	0	120	1	R
Cladophora sp.	0	40	0	0	120	0	0	0	40	4	0	0	204	4	F
Closterium actum (Breb)	0	0	0	0	8	0	0	16	0	0	12	0	36	3	F
Coleastrum combricum Archer.	0	0	8	4	0	0	0	0	0	0	4	0	16	3	F
Cosmarium sp.	0	0	0	0	0	0	0	0	0	0	4	0	4	1	R
Dictyosphaerium pulchellum Wood	0	0	0	0	0	0	0	0	0	0	4	0	4	1	R
Mougetia sp.	0	0	12	60	48	0	0	80	0	0	240	0	440	5	F
Oedogonium sp.	0	152	120	100	168	0	0	0	0	96	0	0	636	5	F

Algal species/ month	2022								2023				Total No.	no. of isolation cases	Rank of occurrence
	M	J	J	A	S	O	N	D	J	F	M	A			
Pandorina sp.	0	0	4	0	0	0	0	0	0	0	0	0	4	1	R
Pediastrum duplex Meyen	0	20	12	4	48	0	0	0	0	0	12	112	208	6	M
Scenedesmus bijuga (Turp) Lagerh	20	24	12	20	128	0	0	36	72	32	32	28	404	10	H
Selenastrum sp.	0	0	0	0	0	0	0	0	160	0	0	4	164	2	R
Spirogyra sp.	0	0	0	0	0	0	0	12	0	0	0	0	12	1	R
Staurastrum sp.	0	0	0	0	0	0	0	0	0	0	20	0	20	1	R
Tetraedron minimum (A.Br.) Hang.	4	0	0	0	0	0	0	0	0	0	12	0	16	2	R
Total number	**24**	**236**	**176**	**200**	**520**	**0**	**0**	**144**	**432**	**732**	**344**	**144**	-	-	-
Cyanophyceae															
Anabaena aequalis	0	0	0	0	0	0	0	32	0	0	120	72	224	3	F
Chroococcus turgidus	400	620	400	420	0	0	800	0	80	320	64	176	3280	9	H
Gomphosphaeria sp.	0	0	0	0	0	0	0	0	0	0	20	0	20	1	R
Rivularia aquatica De Wilde	0	0	0	0	0	0	0	12	72	0	0	0	84	2	R
Lyngbya lacustris Lemm	0	0	0	0	0	0	0	40	0	0	0	28	68	2	R
Merismopedia elegens Braun	0	600	200	400	300	0	0	0	0	64	320	0	1884	6	M
Microcystis aeruginosa Kuetz	60	100	80	72	160	0	0	0	0	0	40	12	524	7	M
Nostoc sp.	300	0	0	0	0	0	0	0	0	0	0	0	300	1	R
Oscillatoria chlorina Kütz. ex Gomo	0	308	280	220	348	600	0	28	160	0	0	168	2112	8	M
Phormidium mucosum Gardner	1400	1600	2000	200	1500	0	0	0	0	0	0	0	6700	5	F
Spirulina major Kütz. ex Gomo.	0	0	0	0	0	0	0	28	0	0	4	0	32	2	R
Total number	**2160**	**3228**	**2960**	**1312**	**2308**	**600**	**800**	**140**	**312**	**384**	**568**	**456**	-	-	-
Euglenophyceae															
Euglena acus Ehrenberg	0	0	0	0	0	0	0	20	24	0	24	0	68	3	F
Phacus sp.	0	0	0	0	0	0	0	0	0	20	4	0	24	2	R
Total number	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**20**	**24**	**20**	**28**	**0**	-	-	-
Total number of genera	**2376**	**3676**	**3256**	**1632**	**2968**	**1760**	**1180**	**512**	**924**	**1144**	**1036**	**640**	-	-	-
Simpson's diversity Index (D)	**0.131**	**0.199**	**0.087**	**0.227**	**0.202**	**0.284**	**0.381**	**0.080**	**0.165**	**0.257**	**0.089**	**0.202**	-	-	-
Margalef's coefficient (D)	**1.544**	**1.584**	**1.978**	**1.622**	**1.626**	**0.535**	**0.283**	**2.725**	**2.050**	**0.994**	**3.025**	**1.702**	-	-	-

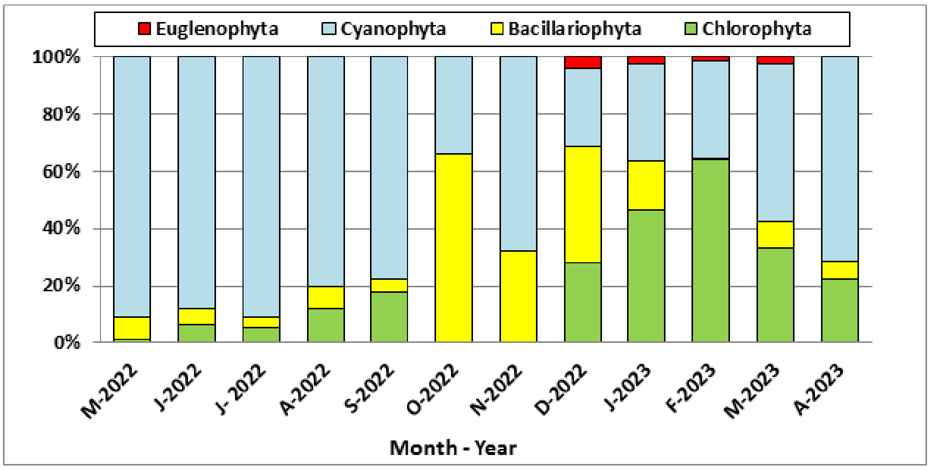

Fig.2. The percentage composition of the main algal groups obtained at Orfaliy drain between May 2022 and April 2023

The second was represented by the Bacillariophyceae (0.7% in February 2023 and 65.91% in October 2022), the third by the Chlorophyceae (63.99% in February 2023 and fluctuated in other months), and the fourth by the Euglenophyceae (low density in some months and complete disappearance in others). Algal diversity is a natural occurrence, and depending on the local climate and water quality, it may persist throughout time. Rich algal flora typically occurs where there are plenty of nutrients, as well as the availability of suitable environmental circumstances. However, according to **Kumar and Sahu (2012)**, human activity frequently stimulates and speeds up algal growth. According to many studies water **(Badr El-Din *et al.*, 2015; El Hadry *et al.*, 2022; Al-Afify *et al.*, 2023)**, drainage water generally had lower algal densities and biomass than irrigation water. This could be explained by the drainage water's higher salt content. The relationship between nitrate and number of algae was explained by **Sabae and Abdel-Satar (2001)**, who noted that the lowest levels of nitrate correlated with the highest values of algal numbers, while the decline in nitrate levels in spring and summer months may have been caused by the nitrate consumption by phytoplankton and reduction of it by denitrifying bacteria. The fluctuations in the full count of microalgae might be caused by a variety of environmental conditions, including chemical and physical factors, water quality, and variations in nutrition levels **(Abdelsalam *et al.*, 2020)**.

The data of Figure (3) reveals that the highest algal species richness (22 genera) was seen in March 2023 and the lowest (3 genera) in November 2022. In Table (2), the occurrence of the representative genera of the various algal groups identified is mentioned. 42 genera were found, including 17 genera of Chlorophycae, 12 of Bacillariophycae, 11 of Cyanophycae, and 2 of Euglenophycae. In March 2023, there will be a maximum of 22 taxa and a minimum of 3 in November 2022. *Cyclotella meneghiniana, Navicula* sp., *Scenedesmus bijuga* and *Chroococcus turgidus* were recorded in a high rank of occurrence, however other recorded species were be found to moderately, frequently or rarely recovered. These result is in agreement with **Adams *et al.* (2013), Abdelsalam *et al.* (2020), Ahmed and Mahran (2022), El Hadry *et al.* (2022) and Al-Afify *et al.* (2023).**

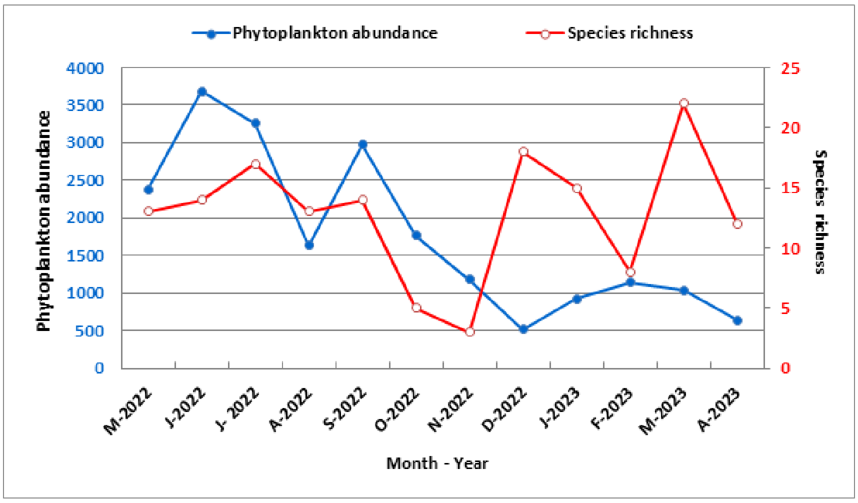

Fig.3. Phytoplankton abundance (taxa number x $10^5\ l^{-1}$) and Species richness in Orfaliy drain during the period from May 2022 to April 2023

The diversity indices Margalef and Simpson were examined in the current research based on the plenty of algae. The data in Figure (4) showed that the maximum diversity index (Margalef) of Orfaliy drain was estimated on the March 2023 sample (3.025) and the minimum was estimated on the November sample (0.283). The results showed that, according to Simpson's diversity (H) index, the maximum phytoplankton diversity was calculated in December 2022 (0.08), while the lowest one (0.381) in November 2022 sample. The Pearson correlation matrix of some variable calculated in Orfaliy drain over the period of investigation was shown in Table (3). The findings indicated that there were some negative and positive correlations between the various variables and algal biomass. While other correlations are positive, the ones between algal biomass and total soluble salts, conductivity, silicate, calcium, magnesium, and potassium are the most important ones. Margalef's index has the advantage of allowing us to compare the richness of different study sites in comparison to the Simpson index, and it also has the advantage of having values that go beyond 1 as opposed to the Simpson index's 0 to 1 range. The index indicates the likelihood that two individuals chosen randomly from one sample will be from different species. In general, the species data indicate that the Orfaily Drain water can be categorized as eutrophic. From the former mentioned results, it was concluded that the phytoplankton groups are very sensitive and helpful indicators to measure the quality of freshwater ecosystems and the health state of any water stream.

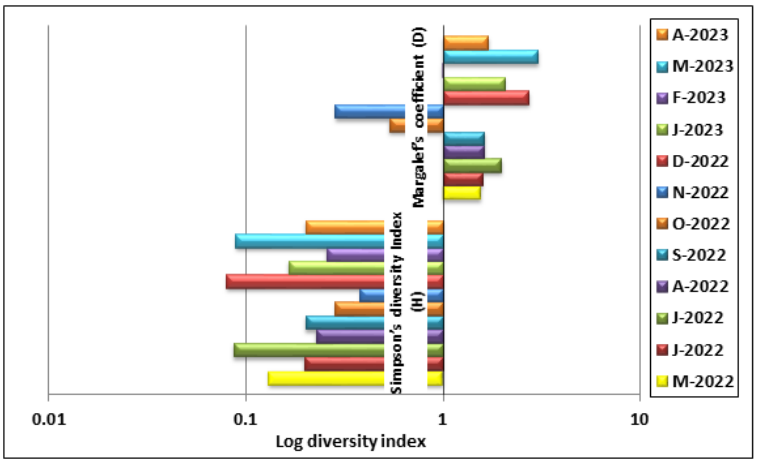

Fig.4. Diversity indexes of mixed phytoplankton in Orfaliy drain during the period from May 2022 to April 2023

Table 3. Pearson correlation matrix of sum variable measured in Orfaliy drain during the investigation period.

Variable	pH	Conductivity	T.D.S.	Total alkalinity	Chloride	Nitrate	Phosphate	Silicate	Ca^{+2}	Mg^{+2}	K^{+}	Na^{+}	Biomass
pH	1.00												
Conductivity	0.09	1.00											
T.D.S.	0.09	1.00	1.00										
Total alkalinity	0.45	-0.35	-0.35	1.00									
Chloride	-0.29	0.72	0.72	-0.26	1.00								
Nitrate	0.04	0.33	0.33	0.09	0.09	1.00							
Phosphate	0.03	-0.24	-0.24	0.41	-0.07	-0.07	1.00						
Silicate	-0.26	0.33	0.33	-0.95	0.16	-0.18	-0.49	1.00					
Ca^{+2}	-0.20	0.79	0.79	-0.25	0.79	0.42	-0.30	0.16	1.00				
Mg^{+2}	0.18	0.83	0.83	-0.14	0.46	0.36	-0.17	0.15	0.55	1.00			
K^{+}	0.34	0.36	0.36	0.27	0.12	0.59	-0.16	-0.20	0.49	0.12	1.00		
Na^{+}	0.08	0.19	0.19	0.25	0.19	0.64	-0.10	-0.34	0.49	0.14	0.51	1.00	
Biomass	-0.20	-0.56	-0.56	0.72	-0.25	0.05	0.45	-0.80	-0.32	-0.24	-0.19	0.07	1.00

(Marked correlation are significant at $p < 0.05$).

References

Abdelsalam, S., Fawzy, M. A., Hafez, W. A. and Fathi, A. A. (2020). Seasonal succession of biomass and microalgal communities in some agricultural drainage at Minia Governorate, Egypt. *Egyptian Journal of of Phycol*ogy, **21, 19-53.**

Adam, M. S., Abdelzahar,H. M. A., Shoulkamy, M. A., Fathi, A. A. and Geneedy, S. N. (2013). Ecological studies of algal flora in some Egyptian paddy fields. Proc. of The International Conference of Environmental Sciences (ICES). **21- 22 May (2013) - pp. 222 - 232**

Adams V.D. (1991). Water and Wastewater Examination Manual, Lewis Publishers, INC. USA. 247 pp.

Ahmed M. K., and Mahran, B. N. (2022). Environmental studies on phytoplankton diversity in drainage water of main drains in Eastern Delta, case study. *The Egyptian Journal of Aquatic Research*, **48(3), 211–216.** https.//doi.org/10.1016/j.ejar.2021.09.007

Al-Afify, A.D.G., Abdo, M.H. and Othman, A.A. (2023). Water Quality and Microbiological Assessment of Burullus Lake and Its Surrounding Drains. *Water Air Soil Pollution,* **234, 385**. https.//doi.org /10.1007/s11270-023-06351-3

Al-Shami S. A., Che Salmah, M.R. and Abu Hassan, A. (2010).. The influence of routine agricultural activities on the quality of water in a tropical rice field ecosystem. *Applied Ecology and Environmental Research,* 8**(1). 11-18**.

Badr El-Din, S. M., Hamed, A. S. A., Ibrahim, N., Shatta A. M and Abo-Sedera, S. A. (2015). Phytoplankton in irrigation and draining water canals of east Nile Delta of Egypt. *Global Journal of Biology, Agriculture & Health Sciences*, **4(2). 56-60**.

Bergstrom, A.K., Jonsson, A., Isles, P.D.F., Creed, I.F. and Lau, C.P. (2020). Changes in nutritional quality and nutrient limitation regimes of phytoplankton in response to declining N deposition in mountain lakes. *Aquatic Science*, **82(2). 31**.

Bourrelly, P. (1981). Fresh Water Algae. Volume II. Chrysophyeae, Phaeophyceae ,Xanthophyceae and Diatoms - Paris. N. Boube's and Co. 517.

Brown, S.D. and Austin, A.S.P. (1973). Spatial and temporal variation in periphyton and physico-chemical condition in the littoral of a lake.- *Arch. Hydrobiology*. **71, 183-232**.

Djumanto, R. E., Inoue, T. and Aoki, S. (2020). Phytoplankton distribution in Mikawa Bay of Japan in relation to temperature and salinity variables. *Wetlands*, **1, 16-25.**

El Hadry, H. H., Shabaan, A. E. and Mansour , H. A. (2022). Phytoplanktonic biomass as an indicator of certain Physico-chemical characters of El Rayah El Tawfiky delta Nile, Egypt. *Egyptian Journal of Phycology*, **23(1), 34–56**. https.//doi.org/10.21608/egyjs. 2022.122136.1010

El-Badawy (2013). Studies on allelopathic potential of macrophytes against phytoplankton at El-Quanater El-Khayria (River Nile, Egypt). Ph.D. Thesisbotany – Phycology), Faculty of Science, Tanta University, Egypt. pp. 269.

Fathi A. A., Abdelzaher, H., Flower, R. J., Ramdani, M. and Kraiem , M. (2001). Phytoplankton communities in North African wetland lakes. The CASSARINA Project. *Aquatic Ecology*, **35 (3-4), 303-318**

Golterman, H.L. and Clymo, R.S. (1971). Methods for chemical analysis of fresh water. IBP n. 8. Blackwell, Oxford, 166p

Hobro, R. and Willen, E. (1977). Phytoplankton counting. In tercalibration results and recommendations for routine work. Int. *Revue ges. Hydrobiol.* **62, 605-811.**

Hussein A. B. (1989). Ecological Studies in pond Ismaelia in El-Minia Province (Egypt). M.Sc. Thesis, Zoology Department, Faculty of Science, El-Minia University, Egypt. pp.210.

Inyang, A.I. and Wang, Y. S. (2020). Phytoplankton diversity and community responses to physicochemical variables in mangrove zones of Guangzhou Province, China, Springer. *Ecotoxicology*, **29(6): 650–668**. https:// doi.org/10.1007/s10646-020-02209-0.

Jaffer, E. M., Al-Mousawi, N. J. and Al-Shawi, J. M. (2023). Impact of some environmental parameters on phytoplankton diversity in the eastern Al-Hammer marsh / southern Iraq. *Baghdad Science Journal*, Online, DOI. https://dx. doi.org/ 10.21123/bsj.2023.7590

Kataria H. C., Iqubal, S. A. and Sandilya, A. K. (1995). Limno-chemical studies of Tawa Reservoir. *Indian Journal of Envoironmental Protection*, **16 (11): 841-846.**

Komarek, J. and Fott, B. (1983). Chlorophyceae, Ordung. Chlorococcales. In. Das Phytoplankton des Süßwassers. Systematik und Biologie, Teil, 7, Stuttgart, 1044pp.

Krishnan, J. R. (2008). Investigation on hydrobiology and water Quality parameters of Periyar lake, Thekkady, Kerala.Ph.D. Thesis (Botany), Mahatma Gandhi University, Kerala. pp.300.

Kumar, A. and Sahu, R. (2012). Diversity of Algae (Cholorophyceae) in Paddy Fields of Lalgutwa Area, Ranchi, Jharkhand. *Journal of Applied Pharmaceutical Science,* **2 (11), 092-095**.

Lashari, K. H., Korai, A. L., Sahato, G. A. and Kazi, T. G (2009). Limnological studies of Keenjhar lake, district, Thatta, Sindh, Pakistan. *Pakistan Journal of Analytical and Environmental Chemistry*, **10 (1-2), 39-47.**

Masoud, M.S., Mahmoud, Th. H. and Abdel-Halim, A. M. (2001). Studies of El-Mex Bay, Alexandria, Proceeding of the Second International Conference and Exhibition for life and Environment, 3-5 April, Alexandria, Egypt . **339-360**.

McCormick, P. V. and Cairns, J. (1994). Algae as Indicators of Environmental Change. *Journal of Applied Phycology,* **6(5-6), 509-526.**

Prescott, G.W. (1987). How to know the fresh water algae, Wm.C. Brown Company Publishers Dubuque lowe, **293 pp**.

Radwan, M., Willems, P. and Berlamont, J. (2004). Sensitivity and uncertainty analysis for river water quality modeling. *Journal of Hydro informatics*, **6(2), 83- 99**.

Sabae, S. Z. and Abdel-Satar, A. M. (2001). Chemical and Bacteriological studies on El-Salam Canal, Egypt. *Journal of Egyptian Academic Society for Environmental Development,* **2(1), 173-197**

Smith, G. M. (1950). The fresh water algae of the United States. 2nd. ed. - New York, McGraw -Hill Co.. **719pp.**

Stevenson, R. J and Pan, Y., (1999). Assessing environmental conditions in Rivers and streams using diatoms. In. E. F. Stoermer and J. P. Smol, (eds.) The Diatoms. Applications for the Environmental and Earth Sciences. Cambridge University Press, Cambridge. **pp 11–40.**

Strickland, J.D.H. and Parsons, T.R. (1972). A practical handbook of sea water analysis. *Fish. Res. Ed. Canada, Bull*. **167, 2 nd ed., 310pp.**

Toma, J.J. and Aziz, F.H. (2022). Algal study in springs and streams from Shaqlawa district, Erbil Province, Iraq I- Euglenophyta *Baghdad Sci J.* **19(3): 483-492.**

Utermöhl, H. (1958). To the perfection the quantitative phytoplankton methodology *Limnologica,* **9, 1-38.**

Willén, E. (1976). A simplified method of phytoplankton counting. British *Journal Phycology,***11, 265-278**

جودة المياه ومجتمعات العوالق النباتية في مصرف أورفيلى– المنيا –مصر

أمنيه ربيع باشا[١], عادل أحمد فتحي[١], زكريا عطيه محمد[٢] , محمود علي شلقامي[١]

١ - قسم النبات والميكروبيولوجي كليه العلوم - جامعه المنيا - مصر

٢ - قسم النبات والميكروبيولوجي كليه العلوم - جامعه سوهاج - مصر

التنوع البيولوجي هو أحد العوامل البيولوجية الهامة في تحديد نوعية المياه والتوازن البيئي. أحد أنظمة الصرف الرئيسية في المنيا هو مصرف أورفيلي . في هذه الدراسة ، تمت مراقبة الاختلافات في كل من الخصائص الفيزيائية والكيميائية والعوالق النباتية لمصرف أورفيلي على مدار عام واحد (من مايو 2022 إلى أبريل 2023). أظهرت جميع متغيرات جودة المياه التي تم قياسها اختلافات شهرية كبيرة. حدثت اختلافات كمية ونوعية موسمية ملحوظة في مجتمعات العوالق النباتية في الصرف. تم الحصول على الحد الأقصى لكثافة المحاصيل (3676 × 105 صنفا /لتر) في يونيو 2022، بينما حدث أقل عدد (512 × 105 صنفا /لتر) في ديسمبر 2022. وتزامنت التغيرات في إجمالي أعداد الطحالب طوال فترة الدراسة بشكل وثيق مع وفرة الطحالب الخضراء المزرقة والطحالب الخضراء. وقد تم تسجيل أربع مجموعات طحلبيه خلال فتره الدراسة وهي: الطحالب العصوية والطحالب الخضراء و الطحالب الخضراء المزرقة والطحالب اليوجلينية. كما تم التعرف على اثنين وأربعين جنسا ، بما في ذلك 17 جنسا من الطحالب الخضراء و 12 من الطحالب العصوية و 11 من الطحالب الخضراء المزرقة و 2 من الطحالب اليوجلينية. تم تواجد بعض الأجناس الطحلبية بشكل وفير خلال فترة الدراسة وهى السيكلوتيلا و النافيكولا و الكروكوككس والسيندسموز , ولكن بقية الأجناس تراوح وجودها بين التواجد المعتدل والتكرر والنادر. بشكل عام، تشير بيانات الأنواع إلى أن مياه صرف أورفيلي يمكن تصنيفها على أنها مثراه غذائيا.