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Impact of some physico-chemical factors distribution on the density of phytoplankton in the Shafya River / Iraq

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***Abstract*---**The study dealt with phytoplankton in the Shafya River, where water and phytoplankton samples were collected monthly from three selected sites starting from December 2021 until May 2022, where physical and chemical factors were studied in addition to the composition of the phytoplankton community in those sites .The results showed the diagnosis of 147 taxonomic ranks of phytoplankton, *Bacillariophyceae* were absolutely dominant in all locations and months with 81 taxonomic ranks, followed by Chlorophyceae, 32 taxonomic ranks, 26 taxonomic ranks to cyanophyceae, 6 ranks to euglenophyceae, and one rank each to Dinophyceae and Crysophyta golden. In this study, some vital evidence such as the Shannon-Weiner Guide, the Jacquard Guide and the Wealth Guide, it was shown through the results that Shannon's values at sites and most months decreased to less than 1 indicating that the water of the Shafya River is contaminated. while the values of Jacquard showed that there is a similarity between the first and second site, the first and third site, the second and third site and in proportions (52.17 - 50.38 - 56.31) respectively, while the evidence of wealth of Marklev through the results shows the increase in the value of the guide in December in the first site amounted to (9.85) which indicates the high diversity of the ShafyaRiver.

***Keywords*---**phytoplankton, quantitative study, qualitative study, Shafya River, Iraq.

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Introductions

Iraq is characterized by many bodies of water compared to neighboring countries, as it is characterized by the presence of fresh water of both types, stagnant and current, which constitute large areas estimated at more than 24,000 km2 (Al-Sahaf, 1976). Iraq has one of the longest rivers in the Middle East, called Euphrates River, which ranks 24th among the longest rivers in the world, estimated to be about 2290 km long, originating from mountainous areas southeast of Turkey (Massoudi, 2000). Rivers are one of the most important sources of fresh water used by humans as the ease of access to them increases their use , Many communities rely on river water for drinking, agriculture, transportation and industrial uses and are ecosystems that provide habitat for various species of organisms such as plants and animals (2005, Murck). Despite the many important and fundamental benefits that cannot be counted, they are the most vulnerable environments to pollution and receive pollutants present in the environment, where pollution is described as the change in the main qualities or components of the environmental component, thus affecting human life and aquatic biology (Hussein, 2001) The presence of phytoplankton species in abundance in natural and industrial aquatic environments and is vital to all aquatic habitats because they constitute the primary food chain and allow the transfer of energy to living organisms (kocer and Sen, 2014).

algae are widely found in fresh water and are one of the important primary products and despite their benefits, they also have negative effects in the water system when they are present in large numbers where they produce what is known as algae blooms that cause an increase in the level of decomposition and decrease of oxygen in the water causing the death of fish and other environmental problems or some of them secrete deadly toxins for both aquatic organisms (Bellinger and Sigee, 2010). Most algae are involved in photosynthesis and are found in fresh, salt water and soil, adhered to the plant and have an important role in the balance of the environment (Tafe, 2009).

Materials and Methods

The current study dealt with three sites of the course of the Shafya River branching from the Diwaniya River Euphrates according to the coordinates, the first site was N=32°,0484967 " E=44°,7718761, the second site N=32°,006853 "E=44,741325, and the third site is located N=31°,923154, " E=44,846281,. Water samples were collected monthly from December 2021 to May 2022. Where the samples were collected by 5-liter polyethylene bottles after being washed with HCL acid (10%) to get rid of impurities and organic matter then washed with distilled water for more than once and finally washed with sample water before taking the sample as the samples were collected 20-30 cm deep from the middle of the river. The temperature of air, water and pH was measured in the field, while the other measurements were performed in the laboratory, which included (electrical conductivity, where the EC conductivity of water was measured in the field using the electrical conductivity meter, while salinity was estimated based on the values of electrical conductivity according to the equation mentioned in APHA (1989).

[Salinity(‰)=Electrical Conductivity (µs/cm) -14.72 ÷ 1589.08]

As for dissolved oxygen according to APHA(2005) ; Lind(1979) while the Biological oxygen demand and total hardness, total alkalinity , silica) according to APHA (2005). The special samples for the quantitative study of phytoplankton are placed in special refrigerated containers, while the special samples for the qualitative study of phytoplankton are collected by the net of collecting phytoplankton with holes a diameter of 20 microns by pulling them against the water stream for 10-15 minutes and then performing the deposition process and taking the last 250 ml and placing them in a cold container if kept in a solution of (Vollenweider, 1974). Phytoplankton is diagnosed based on; Hadi et al.,1984 ;; Bellinger and Sigee: 2010 Munir, et al.,2012 and http://www.algaebase.org/search/species/detail/?species_id=Cd1da6b97f340f66e&distro=y some environmental evidence has been used as the Biodiversity and Water Pollution Index where as the Shannon-Weiner Evidence has been calculated using the following formula (Shannon&Weaver, 1949). Lugol

$$\mathbf{H} = -\sum_{i=1}^{s} pi \ \ln pi$$

S = number of total species, pi = ratio of type i in the component sample of a number of individuals of N. Jaccards also used the presence – Community coefficient to calculate the criterion of jaccards similarity between the studied sites according to the following equation (South wood, 1978).

$$\times 100 \ \mathbf{Isj} = \frac{C}{A+B+C}$$

Isj : Jacquard Coefficient
A: Total number of species in site A
B: Total number of species in site B
This guide was used to illustrate the relationship between the number of species, the number of individuals, their prevalence, and their abundance, where the value of the degree of richness (D) was calculated according to the equation developed by Margalef, 1969 described by (Stiling, 1999).

$$\mathbf{D} = \frac{S-1}{LnN}$$

D: Richness index, S: number of species in the sample, N: Total number of individuals in the sample.

The statistical program used the statistical package for the humanities SPSS version 27 for the purpose of analyzing the study data statistically and for the purpose of knowing the moral differences between the study coefficients, the value of the rate was calculated ± the standard deviation of the studied variables as well as the use of the test of analysis of the single variance One way ANOVA followed by the calculation of the value of the least significant difference LSD as well as the value of Pearson's correlation between the study variables was calculated and the significant differences were determined at the level of probability of 5% (Daniel, 2009).

Results

The air temperature varied in the study sites from the lowest value where it was (12 °C) during December 2021 in the first site to the highest value (31 °C) during May 2020 in the third site while the water temperature ranged from the lowest value (11 °C) in the second site in March 2020 to the highest value of 21(°C) in May 2020 from the first site. As for the values of pH, the study did not show a significant variation in the study sites and for all months, where the lowest value (7.36) was recorded in the first location for the months of March and April 2022 while the highest value was (8.15) in the second site January 2022. While the values of electrical conductivity ranged between (1069-5360) (μs/cm), while the study recorded the lowest concentration of salinity (1.06)‰ in the second location of January while the highest value was (5.35)‰ in the first location of February. While the values of dissolved oxygen ranged between its lowest value (3 mg/L) at the third site of May 2022. The highest value was (8 mg/L) at the first site of December and February, while the values of the Biological oxygen demand ranged between the lowest value of (0.3) mg/L at the second site of December 2021 and April 2022 and the first site of April as well, while the highest value of (3.7) mg/L was recorded at the first site of May 2022. The lowest value for total hardness (528 mg $CaCO_3$/L) was at the 1st of February 2022 , The highest value (2440 mg $CaCO_3$/L) is at the 2nd site of May. While the lowest value of the total base (100 mg $CaCO_3$ / l) at the first site of December 2021 and the highest value was (236 mg $CaCO_3$ / l) at the 2nd site of May 2022. Sulphate values ranged from the lowest value (217.84 mg/L) at the first site of March to the highest value (889.03 mg/L) at the third site of February.

As for the quantitative and qualitative study of phytoplankton, the number of taxonomic units diagnosed during the months of study and in three sites of the river reached 147 taxonomic units, where 50 genera and 85 species were diagnosed at the first site, 33 genera and 60 species at the second site and 44 genera 73 species at the third site The row of Bacillus algae showed complete sovereignty over the rest of the rows of algae followed by green algae then blue green algae then euglena algae then golden and rotary The study was recorded Current is the lowest total number of plankton. The Diatoms class achieved complete sovereignty over the other rows in the three locations. It was clear from the current study that the first site got the highest number of species with 85 species, followed by the third site 73 species while the second site got 60 species. As for the vital evidence, the results of the current study recorded that the diversity ranges of the Shannon-Weiner function ranged between (0.7-1.14) during December and January from the first site and between (0.17-1.12) during the months of March and May in the second site and between (0.42-1.18) during the months of May and January of the third site The table was recorded as the highest rate (0.75) in the first site and the lowest rate (0.66) in the second site. The lowest value (50.38) in the first and third location is table (7). While the current study recorded that the lowest value of the guide (2.58) for the month of March in the first location and the highest value (9.85) for the month of December and for the same site table (8). The results of the current study of silica values were recorded from the lowest value (2.129 mg/L) in the third location of March 2022 to the highest value (10.137 mg/L) in the second locations for May 2022

Discussion

The variation of the total numbers of phytoplankton at different sites and months of study may due tomany environmental factors in different aquatic environments (Koch et al., 2004). An increase in the pH value was observed in January and this is back to the flowering of phytoplankton, which in turn consume co_2 in the form of carbonate or bicarbonate, as well as aquatic plants consume Co_2 during photosynthesis, which leads to a rise in pH values (Al-Jizani, 2005) ,as the increase and decrease in salinity values affects the distribution and diversity of aquatic organisms through their role in ion balance and the osmotic regulation of aquatic organisms (Derry et al., 2003). 1961) . He pointed out that water in which salinity is in the range of (0.05-5‰) is considered brackish water . As for dissolved oxygen, the water of the Shafya River is well ventilated as no lack of oxygen has been recorded in it, as the increase in photosynthesis processes contributes to the mixing of oxygen in the water column back to its rapid melting speed in addition to the lack of breathing at the same time (Olele &Ekelemu, 2008).The increase in the total number of phytoplankton at the first site may due toan increase in the proportion of dissolved oxygen and an increase in nutrients that arrive from cities, agricultural land and wastewater by rainwater (Ayalew & Akoma, 2008). The results noted that the increase in the value of BOD for the month of May, may be attributed to the abundance of aquatic plants and the flowering of phytoplankton, which in turn leads to an increase in the accumulation of plant residues and when the temperature rises, the decomposition processes of organic matter increase (Rikabi, 1992).

The Bacillariophyceae class achieved complete dominance over the other rows through the percentage in the three locations, where the highest percentage was 70% in the third site, while the lowest percentage was for the Dinophyceae and Chrysophyceae rows, where they were 1% in the first site Form, and this is consistent with (Hamdawi, 2009; Al-Ghanmi, 2015). The ability of diatoms to grow in different aqueous organisms may be attributed to the presence of the silica cell wall (Moonsyn et al., 2009), . Diatoms need silica because of its importance in the construction of their structures and the formation of their silica wall, where the silicates in the diatomic cell (26-63)% and this makes silica a determining factor for the growth and distribution of diatoms (Shehata and Bader,2010), The study also showed the continuous appearanceof some phytoplankton species at all sites during the duration of the study *Cocconeis placentula, Cocconeis pediculus, , Cyclotella meneghiniana* and Diatoma *vulgaris*, this may due to the ability of these species to tolerate various environmental factors such as nutrient deficiencies and temperature , in addition alkalinity water is the preferred water for the existence of these species (Qasim et al., 2002). As for the bio indicator, the rise in Shannon values in the current study to higher than one for December and March and in different locations indicates that water is considered medium pollution according to (Wilhm, 1975) in his classification of water quality that Shannon values (1-3) are considered medium pollution waters, while Their reduction to less than 1 may due to a defect in the water ecosystem of the sites studied may due to their exposure to environmental pressures resulting from pollution or human activities (Saadi, 2013). The results of the current study also showed for sites that the first site is the best in the number of species, followed by the third site and then the second site Table (5), At the level of the current study, the first site is the richest in the number of species and algae diversity throughout the duration of the study and the lowest location is the second site table (8). While the values of jaccards coefficient of similarity came close as a result of the presence of prevalent species of diatoms, including *Nitzschia*, *Cymbella*, *Cocconeis*, and *Surirella*, this is consistent with (Fatlawi, 2011; Nasrawi, 2014). As for the index of riches, when comparing its values with the standard values of the index, which ranged from 0- to infinity, the higher the values of the evidence, this indicates the high diversity of phytoplankton and through the results the high value of the evidence in December, which indicates the high diversity of the Shafya River, and the variation of the recorded values of the index of richness may due to the increase in algae during the duration of the study or to the lack of pollution in addition to the lack of grazing processes before. By zoo plankton (Ghosh et al.,2012), . The decline in the values of the Richness index in March and April in the first and third location may be attributed to contraindication in environmental conditions such as phytonutrient light and temperature, which in turn affect phytoplankton, making few species able to resist or adapt to those conditions (Jenkerson and Hickman, 1983). Table (8) The first site is the richest in the number of species for approximately the duration of the study and the lowest at the second site.

Table (5) Diversity of phytoplankton in study sites calculated by the Shannon-Weiner equation

Months		sites	
	S1	S2	S3
December 2021	1.14	0.65	0.60
January 2022	0.7	0.71	0.42
February2022	0.26	0.51	0.95
March2022	0.47	1.12	0.49
April2022	0.99	0.85	0.63
May2022	0.96	0.17	1.18

Table (7) Similarity Coefficient Values - jaccards Phytoplankton Species Diagnosed During Three sites During Study Months

Coefficient Values – jaccards	Sites
52.17	S1×S2
50.38	S1×S3
56.31	S2×S3

Table 8: The richness of phytoplankton species at study sites is calculated by the equation of the Richness indexto Markleaf

Monthes	Sites		
	S1	S2	S3
December2021	9.85	3.49	6.28
January2022	7.48	3.51	4.70
February2022	4.92	4.96	4.19
March2022	2.58	3.93	2.76
April2022	4.85	4.00	2.95

May2022	5.29	5.36	4.78

Table (4) Number of genera and species of phytoplankton classes diagnosed at the study sites of the Shafya River during the study months from December 2021 to May 2020

Sites	S1			S2			S2		
Classes	genera	species	Species %	genera	species	species%	genera	species	species%
Cyanophyceae	7	13	15.29	7	11	18.33	7	9	12.32
Chlorophyceae	14	22	25.88	5	6	10	9	10	13.69
Euglenophyceae	2	2	2.35	1	2	3.33	2	3	4.10
Dinophyceae	1	1	1.17	-	-		-	-	
Chrysophyceae	1	1	1.17	-	-		-	-	
Bacillariophyceae									
Centrales	6	9	10.58	4	7	11.66	5	8	10.95
Pennales	19	37	43.52	16	34	56.66	21	43	58.90
Total	50	85	99.96	33	60	99.98	44	73	99.96

Table (1) Total Preparation of Phytoplankton Cell Species×103/L Diagnosed During the Study Period at Three Sites of the Shafya River (-) means Type Non-Existent

Sites / Phytoplankton	S1	S2	S3
Cyanophyceae			
Anabaena aequalis Borge	-	-	28.4
Oscillatoria curviceps Agardh	71	-	14.2
O.limosa(Rhoth)Agardh	14.2	28.4	-
O. princeps Vaucher	14.2	-	28.4
O. amoena (Kutz.)Gomont	14.2	-	-
O.formosa Bory	-	14.2	-
O. tenuis Ag	-	28.4	-
O. sancta (Kutz.)Gomont	-	42.6	71
O.splendida Greville	-	-	-
Oscillatoria.sp	14.2	-	-
Lyngbya sp	-	28.4	24.6
Phormidium.sp	-	24.6	14.2
P.formosum	-	-	56.8
Pseudanabaena catenata Starmach	-	14.2	24.6
Gloeocapsa magma Brebisson	2.46	-	-
Komvophoron schmidlei	24.6	-	-
Merismopedia punctate Meyen	14.2	-	-
M. eleganus A.braun	-	28.4	-

Merismopedia.sp	-	14.2	-
Monoraphidum contortum Thuret	24.6	-	-
Spirulina Major Kuetzing	14.2	6.71	56.8
S. subsalsa	17	-	-
Spirulina sp	70.8	-	-
Dinophyceae			
Ceratium hirundinella (O.F.Muller)Dujardin	14.2	-	
Chlorophycea			
Actinastrum hantzschii Lagerheim	42.6	-	-
Chodatella.sp	14.2	-	-
Closterium acerosum	-	-	28.4
C.microporum Nageli	-	-	28.4
C. cambricum Archer	28.4	-	28.4
Cladophora glomerata(Li)Kutzing	-	-	-
Eremosphaera tanganyikae. De Bary	-	-	71
Scenedesmus bijuga (Turp.)Lagerhim	14.2	-	-
S.quadricauda(Turp).Lagerheim	56.8	14.2	-
S. apoliensis P.Richter	28.4	-	-
S. aculeolatus	-	-	-
S. obliquns Var.dimorphus	-	-	-
Ulothrix zonata (Weber &Mobr	-	-	-
Ulothrix sp	71	42.6	-
Spirogyra crassa Kuetzing	42.6	14.2	-
S. nitida	28.4	-	-
S. borgeana	-	-	28.4
Spirogyra.sp	14.2	42.2	-
Chlorella vulgaris Bejerinck	156.2	99.4	-
C.ellipsoidea Gerneck	71	-	-
Cladophora sp	28.4	-	-
Coelastrella terrestri	-	-	42.6
Chodatella.sp	-	-	-
Selenastrum sp	14.2	-	-
Staurastrum sp	14.2	-	-
Zygnema sp	14.2	-	-
Rhizoclonium.sp	28.4	-	56.8
Oedogonium itzigsohnii	-	-	28.4
Oedogonium sp	71	14.2	-
Oocystis sp	113.6	-	-
O.crossa Wittrock	28.4	-	-
Euglenophyceae			
Euglena. haematodes Ehrenberg	-	14.2	-
E.mutabilis	28.4	28.4	-
E.peoxima Dangeard	-	-	24.6
Euglena sp	28.4	-	14.2

Phacus.sp	-	-	56.8
Chrysophyceae			
Tribonema minus (wille) Hazen	99.4	-	-
Bacillariophyceae			
Centrales			
Aulacoseira ambigua Muller	7.26	-	-
Aulacoseira granulate(Her.)Ralfs	-	-	4.84
Melosira granulate(Her).Ralfs	12.1	-	-
Melosira varians Agardh	-	4.84	12.1
Cyclotella meneghiniana Kuetzing	21.78	4.84	203.28
Cyclotella ocellata Pantocsek	24.38	2.42	7.26
Cyclotela sp	2.42	4.84	-
Cocconeis placentula Ehrenberg	229.9	31.44	21.78
Cocconeis pediculus Ehrenberg	198.34	21.96	16.94
Coscinodiscus radiates	12.1	12.1	16.94
Tryblionella granulate	7.26	-	-
Pennales			
Achnanthes exigua var.hetero valve Krasske	7.26	-	-
Cymatopleura solea(Breb.)W.Smith	16.49	65.34	31.46
C. elliptica (Breb)W.Smith	-	-	2.42
Craticula cuspidate Ehrenberg	2.42	14.52	4.84
C.tumida Breb van . Heurck	-	-	7.62
C. turgidula var. kappii cholnoky	12.1	-	-
C. aspera	-	-	4.84
C. affinis Kuetzing	12.1	7.26	4.84
Cymbella sp	16.94	4.84	-
Caloneis permagna(Bail.)Cleve	2.42	53.24	21.78
C.amphisbaena(Bory)Cleve	-	9.68	12.1
Bacillaria paxillifera(Muell).Hendey	12.1	19.36	12.1
Diatoma vulgaris Bory	123.62	9.68	-
Entomoneis alata	7.26	-	14.52
E.paludosa Romny.	2.42	-	-
Eunotia minor (Kutzing) Grunow	2.42	-	-
Hantzschia amphioxys (Ehrenberg)Grunow	2.42	-	-
Gyrosigma attenuatum (Ktz.)Rabenhorst.	4.84	-	14.52
G. fasciola (Ehr).Griffet Henfr.	2.42	-	7.26
G. parkerii(Harrison)Elmore	4.84	4.84	-
G.scalproides (Rabenhorst)Cleve	-	7.26	4.84
G. acuminatum	-	-	4.84
Gomphonema angustatum (Kuetz.)Robenhors	19.36	16.94	-
Gomphonema sp	-	2.42	-
G.tenellum	-	4.84	4.84
G.lanceolatum Ehrenberg.	-	4.84	4.84
Fragilaria sp	4.84	-	-
Fragilaria. vaucheria (Ktz.)Boye-peters	4.84	-	-

Navicula viridula v(Etz.) Ehrenberg.	4.84	-	9.68
- N. elginensis W.Smith	-	-	4.84
N.placentula(Ehrenberg)Kutzing	21.78	16.94	-
N.subrhyncocephala	7.26	7.26	-
N. crucicula (W. Smith)Denkin	-	-	-
N.subrhynchocephala Hustedt	-		-
Nitzschia obtuse W. Smith	7.26	16.94	21.78
N . sigma (Kuetz.)W.Smith	7.26	12.1	21.78
N.linearis (Agardh)W Smith	4.84	9.68	12.1
N. hungarica Grunow	4.84	24.2	-
N. reversa W.Smith	9.68	-	9.68
N.capitatoradiata nomen novum.(w.smith	-	-	4.84
N.clausii hantz.	7.26	-	-
N.amphibian Grun.	9.68	-	-
N.levidensis(W Smith)Grunow	-	-	4.84
N. colsterium(Ehrenberg) W smith	-	-	4.84
N.tryblionella Hantzsch	-	-	4.84
Halamphora ghanensis	-	-	2.42
Surirella tenera Gregory	4.84	24.2	12.1
S. brebissonii Krammer&Bertalot	-	65.34	-
S. capronii Hantzsch	-	70.18	-
S. ovate Kuetzing	2.42	23.68	-
Surirella sp	2.42	-	12.1
Synedra ulna (Nitz.)Ehrenberg	7.26	7.26	7.26
S. affins var. faciculata (kutz)Grun	7.26	2.42	7.26
S. acus Kuetzin	-	2.42	4.84
S. tenera	-	-	7.26
Stauroneis acuta W.Smith	2.42	-	-
S. anceps Ehrenberg	-	-	9.68
Pinnularia brebissonnii (Kuetz)Robenhorst	7.26	-	-
Pinnularia sp	2.42	12.1	9.68
Pleuropsis sp	-	-	12.1
Rhoicosphenia curvata (Kuetz.)Grunow	2.42	9.68	53.24
R. marina	2.42	-	-
R.gibba (Ehr).O Muller	-	-	7.26

Parameter	S1	S2	S3
AT° temperature Air	12-29 17.83-5.91	25-16 18.17±3.54	31-18 21.83±4.96
Water temperature WT°	21-12 14.67±3.33	20-11 15.00±2.97	20-14 17.00±2.45
Ph	8.09-7.36 7.74±0.37	8.15-7.58 7.84±0.24	8.04-7.59 7.81±0.22
EC µS/cm	5360-1469 2132±1586	4970-1069 2657.7±1734	4480-1420 2571.7±1037
Salinity‰	5.35-1.34 2.13±1.59	4.96-1.06 2.65±1.73	4.47-1.41 2.56±1.04

TH Mg/l	668-528 600.00±64.8	2440-584 1145.67±739.8	1990-744 1154.33±491.1
Total Alkalinty	134-100 120.33±13.7	236-102 148.33±49.8	234-122 168.67±37.6
SiO_2 Mg/l	5.902-2.464 3.84±1.44	10.37-2.7 5.82±2.58	8.547-2.129 5.67±2.16
DO Mg/l	8-4.3 6.57±1.61	7.7-4 6.23±1.52	7.7-3 5.68±1.76
BOD Mg/l	3.7-0.3 1.78±1.27	1.9-0.3 0.78±0.62	2.9-0.6 1.58±0.89

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