Original Article

Ecological and Taxonono study on phytoplankton in AL-Shafya river/Iraq

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Abstract

This study included three sites from AL- Shafya River which is divaricate from the Diwaniya River in the Sunni area arrival to the Shafya Township, Water and phytoplankton samples were collected monthly for three sites from December 2021 to May 2022, number of physical, chemical and biological tests, air temperature, water temperature, pH,electrical conductivity, salinity, total suspended solid materials, dissolved oxygen, biological oxygen demand, total alkalinity and total hardness, calcium ion, magnesium, sulfate, phosphate, nitrite, nitrate and silica, study of the phytoplankton community in three locations ,the study showed the diagnosis of 147 Taxono of phytoplankton of these species, 26 species belonging Cyanophyceae, 32 species to Chlorophceae , 6 species to Euglenophyceae, one species each to Dinophyceae and Chrysophyceae , 81 species to Bacillariophyceae , where they varied to 11 species to pannales and 70 species to feathery diatoms.

Keywords: qualitative study, quantitative study, phytoplankton, Shafya River, Iraq.

INTRODUCTION

Rivers are one of the most important sources of fresh water used by humans as their ease of access increases their use, and many societies depend on river water for drinking, agriculture, transportation and industrial uses and they are ecosystems that provide habitat for various species of living organisms such as plants and animals (Murck ,2005). Water is the basis of life where human civilizations flourished when there was pure and reliable freshwater Human use of water for drinking, washing and any other use must be without any chemical, physical and biological contaminants. Plants, animals and habitats of biological diversity need clean water (palaniappan et. al, 2010). Water is one of the most important chemical compounds that is associated with life because of its unique properties that cannot be combined in another liquid, such as its ability to form hydrogen bonds and its high specific temperature compared to the size of its molecule in addition to being a good solvent of many substances, and other characteristic qualities of him. This contributed to making Earth the only planet that has the distinction of being the planet of water and life (Abed and Safarini, 2004).

Iraq is characterized by many water bodies compared to neighboring countries, as it is characterized by the presence of fresh water of both running and stagnant types, which constitute large areas estimated at more than 2400 km2 (Al-Sahaf, 1976). Algae exist in the form of phytoplankton that moves according to the movement of water, even if it is whipped, but its movement is very simple for the accuracy of its size. Or they are fixed on a rocky or sandy benthic support or even installed on some epiphytes or fauna and in this case they are called seaweeds (boughdeiri, 2012). Algae carry out photosynthesis, are coexist in fresh, salt water and soil, are attached to the plant and have an important role in the balance of the environment (Tafe, 2009).

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Access this article online

Quick Response Code:

Website: www.pnrjournal.com

DOI: 10.47750/pnr.2022.13.03.158

How to cite this article: Mustafa Jafar Sadiq Al-Ghabban, Raid Kadhim Abed Al –Asady, Ecological and Taxonono study on phytoplankton in AL-Shafya river/Iraq, J PHARM NEGATIVE RESULTS 2022;13: 1011-1018.

Part of these algae are belongs to the group of primitive organisms such as the blue-green algae Cyanophyta, while the rest are of Eukaryotes such as the green algae Chlorophyta, the brown algae Phaeophyta, and the Bacillariophyta algae (Graham and Wilcox, 2000).

The aims of the study:

1. To assess water quality of AL-Shafya river through estimating of some physical and chemical measurements.

2. A qualitative and quantitative study of the phytoplankton community at study sites.

3. Idification of phytoplankton found at three sites of the Shafya River.

4.To determine the distribution of phytoplankton in AL-Shafya river.

Materials and methods: -

The Shafya River is one of the rivers branching from the Diwaniya River, which is the longest waterway that passes through Diwaniya Governorate, branching from the Euphrates River, where it is long 30 km, irrigating an area estimated at (91,630 acres) distributed between the Shafi'iya and Sudair district, and is also one of the important rivers in Diwaniya Governorate because of its economic importance in agricultural production, where it irrigates large areas of agricultural land, the river is characterized by a muddy bottom and sees on its banks agricultural activity along the river Three locations on this river have been selected and according to GPS values Table (1)

Table (1) Represents GPS values for study locations

Sites	N	E
S1	32º,0484967	44º,7718761
S2	32º,006853	44,741325
S3	31º,923154	44,846281

Water samples were collected monthly for three sites of the Shafya River in Diwaniya Governorate starting from December 2021 until May 2022 and at a rate of once a month and about 30 cm deep below the surface of the water, where samples were collected from the study sites using slittres plastic bottles, where some measurements were measured in the field during the collection of samples such as air and water temperature, pH and conductivity, dissolved oxygen and biological oxygen demand. APHA (2005) and others were laboratory-measured which included total suspended solid materials APHA (2005), and total hardness. APHA(2005) and total basal, calcium ion, magnesium, sulfate, phosphate, nitrite, nitrate and silica APHA(2005); APHA,2005; parsons et .al.(1984); Al-Muthanani and Al-Salman (2007), while the quantitative study of phytoplankton followed the sedimentation method, and the samples for the qualitative study of phytoplankton were collected by the Phytoplankton Collection Net (Furet and Benson, 1982), with holes diameter of 20 micrometers where the net is placed in the middle of the river and drag for 15 minutes and then the sample collected by the net is placed in plastic bottles after that a few drops of lugol solution are added (Prescott, 1979). For the study of phytoplankton other than the diatoms variety, non-permanent slides were prepared and test at a strength of 40X using a compound microscope or by preparing a haemocytometer prescot, 1973, Hassan et.al,(2012), Desikachary,1959, Husted,1930.

Results and discussion: -

The results of the study of physical and chemical factors showed. There is a variation in air and water temperatures during the collection of samples. The highest rate was 21.83 º C in the third site and the lowest rate was 17.83 º C in the first site, while for the water temperature, the highest rate was 17.00 º C in the third site, 14.67 º C in the first site. The results of the statistical analysis showed a positive significant correlation between air temperature and water temperature($r=0.850$) $p<0.01$. The correlation may be attributed to the difference in the time of collection of samples as the temperature increases as we approach middle of because of increased solar radiation (Ahipathy & Puttaiah, 2006)

Table (2) of Range (first line), rate and standard deviation (second line) of physical, chemical and biological factors at study sites in the Shafya River during the study months

Study Locations Environmental factors	S1	S2	S3
Air temperature (mº)	**29-12 17.83±5.91**	**25-16 18.17±3.54**	**31-18 21.83±4.96**
Water temperature (mº)	**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**
Electrical conductivity	**5360-1469 2132.0±1586**	**4970-1069 2657.7±1734**	**4480-1420 2571.7±1037**

(Microsimens /cm))			
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**
Suspended solids (mg/L(	**35.6-3.3 13.41±11.8**	**40.4-2.7 20.55±14.7**	**247.6-5.2 57.16±93.5**
Dissolved oxygen (mg\L)	**8-4.3 6.57±1.61**	**7.7-4 6.23±1.52**	**7.7-3 5.68±1.76**
Biological oxygen demand(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**
Total alkalinity (mg\L)	**134-100 120.33±13.7**	**236-102 148.33±49.8**	**234-122 168.67±37.6**
Total hardness (mg\L)	**668-528 600.00±64.8**	**2440-584 1145.67±739.8**	**1990-744 1154.33±491.1**
Calcium(mg/L)	**145.6-120 132.53±11.2**	**360-128 200.27±96.4**	**264-161.6 208.53±44.7**
Magnesium (mg/L)	**78.08-55.63 65.55±9.59**	**375.76-64.41 146.40±127.2**	**302.56-82.96 150.79±87.1**
Sulfate(mg/L)	**437.4-217.84 295.86±96.7**	**842.9-237.29 477.40±291.4**	**889.03-292.02 551.53±221.8**
Nitrite (mg/L)	**0.18-0 0.08±0.06**	**0.199-0 0.10±0.07**	**0.173-0 0.07±0.7**
Nitrates (mg/L)	**3.997-1.561 2.61±0.91**	**2.878-0.77 2.14±0.84**	**3.177-0.894 2.20±1.04**
Phosphate (mg/L)	**0.054-0 0.013±0.02**	**0.207-0 0.055±0.07**	**0.265-0 0.059±0.09**
Silica (mg/L)	**5.902-2.464 3.84±1.44**	**10.137-2.7 5.82±2.58**	**8.547-2.129 5.67±2.16**
Total number of phytoplankton (cell×103/L)	**664.84-136.4 426.23±175.6**	**332.06-95.84 218.21±85.9**	**337.72-71.64 266.63±208.1**

Temperature is one of the important fundamental factors for many factors such as humidity, evaporation and wind movement, in addition to its impact on the properties of water such as density, surface tension, viscosity, pH and chemical content of dissolved oxygen as well as other characteristics, and these characteristics are among the factors influencing the determination of the activity and affective of aquatic organisms (AL-mathane and Salman, 2007, Janabi, 2011). While the highest pH rate was 7.84 at the second site and the lowest rate were 7.74 at the first site. An increase in the pH value was observed in January and this is because of the growth of phytoplankton, which in turn consume carbon dioxide in the form of carbonate or bicarbonate, as well as aquatic plants consume carbon dioxide during the process of photosynthesis, which leads to a rise in pH values (Al-Jizani, 2005) and the results of this study came in close proximity to many studies (Al-Makdami, 2016, Al-Ghanmi, 2003).)

As for electrical conductivity, the highest rate was 2657.7 µcm/cm at the second site and the lowest rate was 2132.0 µcm/cm at the first site, as noted from the results of the current study The high conductivity values in February may be attributed to the decrease in temperature and low water level as a result of the water quotas coming from the main source of the Euphrates River (Al-Ghanmi, 2011, Saadi 2013) or the reason for the increase in conductivity and salinity may be a result of the decrease in water level and the increase in the rate of evaporation as a result of the high temperature (Al-Kenzawi,2007 While the highest rate of dissolved oxygen was recorded at 6.57 mg/L at the first site and the lowest rate of 5.68 mg/L at the third site, the results of the statistical analysis showed that there were significant differences between the months while no significant differences were recorded between the study sites $p>0.05$ The decrease in the values of dissolved oxygen in May as a result of the rise in temperature during this month (Ibanez et.al, 2007) This is what the statistical analyses have shown, as they gave a negative significant correlation between the concentration of dissolved oxygen and the temperature ($r=-0.684$) $p<0.0.01$. These results were consistent with (Hamdawi 2016, Al-Ghanmi, 2015) in terms of the above reason as the rise in temperature leads to increased biodegradation and therefore consumes oxygen in addition to the possibility of residues containing organic substances that have oxidation (Thakor et.al, 2011) 147 taxonoof phytoplankton were identified in this study, where the number of species of Bacillariophyceae species reached 81 species, where they varied to 11 species of central diatoms, 70 species of Pennales, 26 species to cyanophyceae, 32 species to Chlorophyceae, 6 species to

euglynophyceae, and one species each to Dinophyceae and Crysophyta and the number of species varied as follows 85 species in the first site 60 species In the second site 73 species in the third site. Monthly changes in the total number of phytoplankton were evident at the study sites at the first site recorded the lowest density (136.46 cells×103/L) during March 2022 and the highest density (664.84 cells×103/L) during April, while for the second site the lowest density was 95.84 cells×103/L during January, the highest density (332.06cells×103/L) in December and the lowest density for the third site was 71.64 cells×103/L and the highest density was 633.94) cells×103/L) Table (2) while the highest The average of the total number of phytoplankton is 426.23 at the first site and the lowest rate is 218.21 at the second site, and the results of the statistical analysis showed significant differences for the month of March compared to the rest of the months except December and January, while no clear significant differences were shown in the P<0.05 sites. The percentage showed that Bacillus algae were prevalent in all locations, and this is consistent with (Lami and Salman, 2003). On the Euphrates River, the increase in the total numbers of phytoplankton in April in the first site, where the total phytoplankton reached 664.84 cells ×103/liter, may be due to the availability of nutrients in it more than the second and third site due to the additions from the surrounding agricultural land and houses waste resulting from the passage of the river in the neighboring residential areas (kasim and Ismail, 2002). The result of the mitigation caused by rising water levels or increased flow speed, which in turn affects the growth of phytoplankton by moving them to places that are not suitable for them (Antoniades and Douglas, 2002).

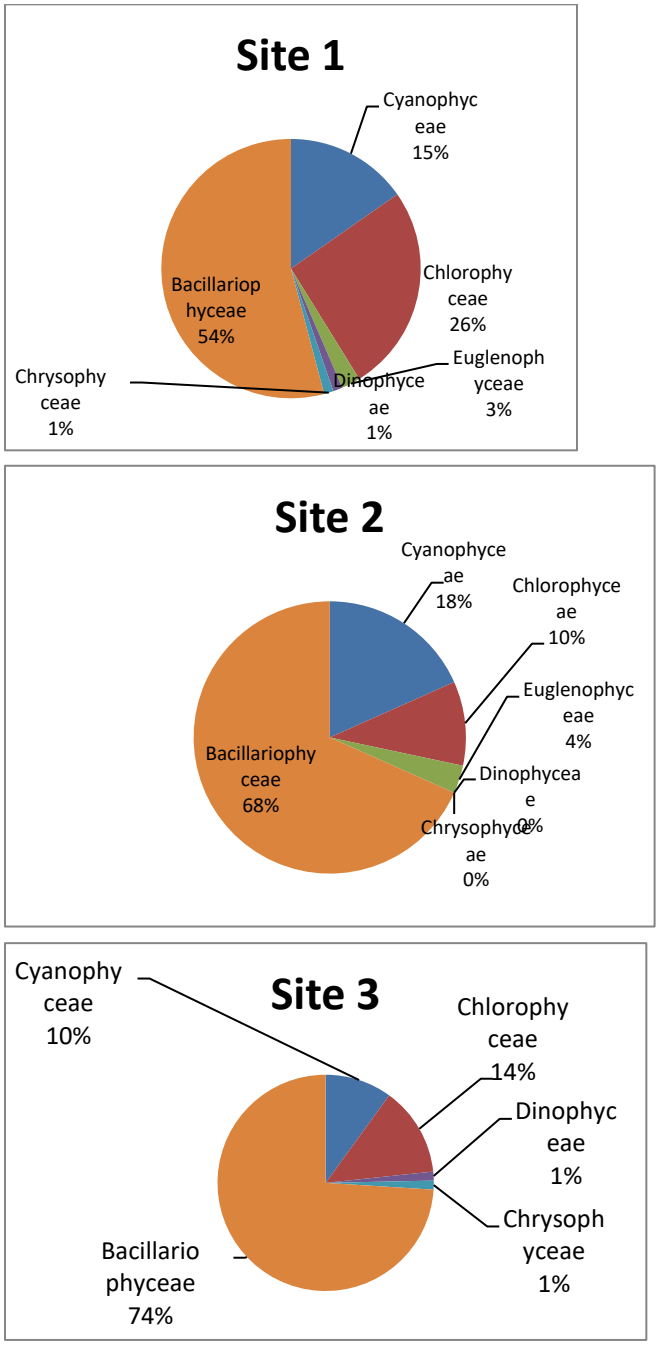

Figure (1) Percentage of phytoplankton species recorded at the study sites of the Shafya River during the study months

Table (2) Phytoplankton species identified during the study period at three sites of the Shafya River. (+) means type exists (-) means type does not exist

months / Phytoplankton	December 2021	January 2022	February 2022	March 2022	April 2022	May 2022
Cyanophyceae						
Oscillatoria curviceps ***Agardh***	+	+	-	-	-	-
*O.limosa(Rhoth)****Agardh***	+	-	-	+	-	-
O. princeps ***Vaucher***	-	+	+	-	+	-
*O. amoena (****Kutz.)Gomont***	+	-	-	-	-	-

O.formosa Bory	+	-	-	-	-	-
O. tenuis ***Ag***	-	-	-	-	+	-
*O. sancta (****Kutz****.)Gomont*	+	+	+	+	+	-
O.splendida ***Greville***						
Oscillatoria.sp	-	+	-	-	-	+
Anabaena aequalis ***Borge***	+	-	-	-	-	-
Phormidium.sp	-	-	-	-	+	-
Phormidium formosum	-	-	+	+	-	-
Pseudanabaena catenata ***Starmach***	+	-	+	-	-	-
Gloeocapsa magma ***Brebisson***	-	-	-	-	+	-
Komvophoron schmidlei	-	+	-	-	-	-
Lyngbya SP	-	-	+	-	-	-
Merismopedia punctate ***Meyen***	-	-	+	-	-	-
Merismopedia.sp	-	+	-	-	-	-
*Merismopedia eleganus A.****braun***	+	-	-	-	-	-
Monoraphidum contortum ***Thuret***	-	-	-	-	+	-
Spirulina Major ***Kuetzing***	+	-	-	+	+	-
Spirulina subsalsa	-	-	+	-	+	-
Spirulina sp	-	-	+	-	+	
Dinophyceae						
Ceratium hirundinella ***(O.F.Muller)Dujardin***	-	+	-	-	-	-
Chlorophycea						
Actinastrum hantzschii ***Lagerheim***	-	-	-	-	-	+
Chodatella.sp	-	-	-	-	+	-
Closterium acerosum	+	-	-	-	-	-
C.microporum ***Nageli***	-	-	-	-	-	+
C. cambricum ***Archer***	-	-	-	-	-	+
*Cladophora glomerata(Li)****Kutzing***	-	-	+	-	-	+
Eremosphaera tanganyikae. ***De Bary***	-	-	+	-	-	-
Scenedesmus bijuga ***(Turp.)Lagerhim***	-	-	-	-	+	-
*S.quadricauda(Turp).****Lagerheim***	+	+	-	-	-	+
Scenedesmus apoliensis ***P.Richter***	-	-	-	-	+	-
Scenedesmus aculeolatus	-	-	-	-	-	+
Scendesmus obliquns ***Var.dimorphus***	-	-	-	-	-	+
Ulothrix zonata ***(Weber &Mobr***	-	-	+	-	-	+
Ulothrix sp	-	-	+	+	+	+
Spirogyra crassa ***Kuetzing***	+	-	+	+	-	-
Spirogyra nitida	+	-	-	-	-	+
Spirogyra borgeana	-	+	-	-	-	-
Spirogyra.sp	-	-	+	-	-	-
Chlorella vulgaris ***Bejerinck***	-	-	-	+	+	+
C.ellipsoidea ***Gerneck***	-	-	+	-	-	-
Cladophora sp	+	+	-	-	-	-
Coelastrella terrestri	-	+	-	-	-	-
Chodatella.sp	-	-	-	-	-	+
Selenastrum sp	-	-	-	-	-	+
Staurastrum sp	-	-	-	-	+	-
Zygnema sp	-	-	-	+	+	-
Rhizoclonium.sp	+	-	+	-	+	-
Oedogonium sp	-	+	-	-	+	-
Oedogonium itzigsohnii	-	-	+	-	-	-
O.crossa ***Wittrock***	+	-	-	-	-	-
Oocystis sp	-	+	-	-	+	-

Euglenophyceae						
Euglena. haematodes ***Ehrenberg***	-	-	+	-	-	-
E.mutabilis	+	-	-	+	-	-
E.peoxima Dangeard	-	-	-	-	-	+
Euglena sp	+	-	-	-	-	+
Phacus.sp	+	-	-	-	-	-
Chrysophyceae						
*Tribonema minus (**wille**) **Hazen***	+	+	-	-	-	-
Bacillariophyceae						
Centrales						
*Melosira granulate(Her).**Ralfs***	+	+	-	+	-	-
*M. varians **Agardh***	-	+	+	-	-	-
*Cyclotella meneghiniana **Kuetzing***	+	+	+	-	-	+
C. ocellata Pantocsek	+	-	-	+	-	+
Cyclotela sp	-	+	+	+	-	+
*Cocconeis placentula **Ehrenberg***	+	+	+	+	+	+
*Cocconeis pediculus **Ehrenber**g*	+	+	+	+	+	+
Coscinodiscus radiates	+	+	+	+	-	+
Tryblionella granulate	+	-	-	-	-	-
Pennales						
Achnanthes exigua var.hetero valve ***Krasske***	-	-	+	-	-	-
Cymatopleura solea ***(Breb.)W.Smith***	+	+	+	+	-	+
*C. elliptica **(Breb)W.Smith***	+	+	-	-	-	-
*Craticula cuspidate **Ehrenberg***	+	+	-	-	-	+
*C.tumida **Breb van . Heurck***	+	-	-	-	-	-
*C. turgidula **var. kappii cholnoky***	-	-	-	+	+	-
C. aspera	+	-	-	-	-	-
*C. affinis **Kuetzing***	-	+	+	-	+	-
Cymbella sp	-	-	-	+	-	+
*Caloneis permagna(**Bail.**)**Cleve***	+	+	+	+	-	+
*C.amphisbaena(**Bory**)**Cleve***	-	-	-	-	-	+
*Bacillaria paxillifera(**Muell**).Hendey*	+	+	+	-	+	-
*Diatoma vulgaris **Bory***	+	-	+	-	+	+
Entomoneis alata	+	+	-	+	+	-
*E.paludosa **Romny**.*	-	+	-	-	-	-
*Eunotia minor **(Kutzing) Grunow***	-	+	-	-	-	-
Hantzschia amphioxys ***(Ehrenberg)Grunow***	+	-	-	-	-	-
*Gyrosigma attenuatum (Ktz.)**Rabenhorst.***	+	+	-	-	-	+
*G. fasciola **(Ehr).Griffet Henfr**.*	+	-	-	-	-	+
*G. parkerii(**Harrison**)**Elmore***	+	-	-	-	-	+
*G.scalproides (**Rabenhorst**)**Cleve***	-	-	-	-	+	+
G. acuminatum	-	-	+	-	-	-
Gomphonema angustatum ***(Kuetz.)Robenhors***	+	-	+	+	+	-
Gomphonema sp	+	-	-	-	+	-
G.tenellum	-	+	+	-	-	-
*G.lanceolatum **Ehrenberg**.*	-	-	+	+	-	-
Fragilaria sp	+	-	-	-	-	-
*Fragilaria. vaucheria (**Ktz.**)**Boye-peters***	-	-	-	-	+	-

*Navicula viridula v(**Etz**.) **Ehrenberg**.*	+	-	-	-	-	+
*N.placentula(**Ehrenberg**)**Kutzing***	-	-	-	-	+	+
N.subrhyncocephala	-	+	-	-	+	-
*N. crucicula (**W. Smith**)**Denkin***	+	-	+	+	-	-
*N.subrhynchocephala **Hustedt***	-	+	+	-	-	-
*Nitzschia obtuse **W. Smith***	+	+	+	-	+	+
*N . sigma **(Kuetz.)W.Smith***	+	_	-	+	-	+
*N.linearis **(Agardh)W Smith***	+	+	+	+	-	+
*N. hungarica **Grunow***	+	-	-	-	-	+
*N. reversa W.**Smith***	-	-	-	-	+	-
*N.capitatoradiata nomen **novum**.(w.**smith***	-	-	+	-	-	-
N.clausii Hantz.	-	-	+	-	+	-
*N.amphibian **Grun**.*	+	-	+	-	-	-
*N.levidensis(W **Smith**)**Grunow***	+	-	-	-	-	-
*N. colsterium(**Ehrenberg**) W smith*	-	+	-	-	+	-
*N.tryblionella **Hantzsch***	-	-	+	-	-	-
N.elginensis W.Smith	+	-	-	-	-	+
Halamphora ghanensis	-	+	-	-	-	-
*Surirella tenera **Gregory***	-	+	-	+		+
*S. brebissonii **Krammer&Bertalo**t*	+	-	-	-	+	-
*S. capronii **Hantzsch***	+	-	+	-	-	+
*S. ovate **Kuetzing***	+	+	-	-	-	+
Surirella sp	-	+	-	-	-	-
*Synedra ulna **(Nitz.)Ehrenberg***	+	+	-	+	-	-
*S. affinis var. faciculata (**kutz**)Grun*	-	-	+	-	-	-
*S. acus **Kuetzin***	-	-	+	+	-	-
Synedra sp	-	+	+	-	+	-
Stauroneis acuta W.Smith	-	-	+	-	-	-
*S. anceps **Ehrenberg***	-	+	-	-	-	-
Pinnularia sp	-	-	+	-	-	-
*P. brebissonnii (**Kuetz**)**Robenhorst***	+	-	+	+	-	-
Pleuropsis sp	-	+	+	-	-	-
*Rhoicosphenia curvata (Kuetz.)**Grunow***	+	-	-	-	+	-
R. marina	-	-	-	-	+	-
*R.gibba (Ehr).O **Muller***	+	-	-	-		+

Table (3) monthly changes of the total number of phytoplankton cells (cell×103/L) at study sites during the study months

Study Locations Months	S1	S2	S3
December 2021	427.8	332.06	337.72
January 2022	358.28	95.84	189.26
February 2020	454.16	139.38	633.94
March 2020	136.46	235.74	86.48
April 2020	664.84	256.56	71.64
May 2020	515.86	249.72	280.76

References

1- Al-Jizani, Hana Radi Golan Ibrahim (2005). Organic pollution and its impact on the diversity and abundance of plankton in the Shatt al-Arab, the channels of Al-Ashar, Rabat and the college of Education. University of Basrah 82p.

2- . Al-Muthani, Abdul Salam Mohammed and Al-Salman, Ibrahim Mahdi Azzouz (2007), Practical Environment Field and Laboratory Studies, First Edition, Sabha University Publications, Libya: 407 p.

3- Abed, Abdul Qader and Safarini, Ghazi (2004).Fundamentals of Ecology.Third Edition. Wael Printing House and Al-Mishr 328p.Amman, Jorden

4- Ahipathy, M.V.&Puttaiah, E.T. (2006)Ecological characteristics of Vrishabhavathy River in Bangalore (India) Environmental Geology , Vol . 49(8), pp: 1271-1222.

5- AL-arbi Boughdeiri (2012) Primitive Plants Thalluses bureau University Publications. Publish No. 1.04.5234.

6- Al-Ghanmi, Dunia Bahl Jadaan Salal. (2015) Evaluates the water quality of the Euphrates River (between the cities of Al-Kafel and Shanafiya) in central Iraq PhD thesis, college of Education – University of Qadisiya.

7- Al-Ghanmi, Haidar Abdul Wahid Malek. (2003). Environmental and Taxononomic Study on pytoplanktonin the Northern Part of the Diwaniya River and their Effects on the Water Filter Station,MASTER

Thesis, college of Education – University of Qadisiyah 83 p.
8- Al-Ghanmi, Hussein Allawi Hussein (2011). The use of aquatic plants as a living evidence of pollution by heavy elements in the Euphrates River - Iraq, MASTER Thesis .college of Science - University of Babylon.
9- Al-Kenzawi (2007). Ecological study of aquatic macrophytes in the central part of the Marshes of Southern Iraq . M. Sc thesis, College of Science for Women, University of Baghdad , 270 pp.
10- Al-Makdami, Buthaina Abdul Aziz Hassan (2016) A study of the algae community (ditoms) in the Tigris River between Bagdad and the Dujail region, PhD thesis, Faculty of Education for Pure Sciences-Ibn al-Haytham 64 p.
11- Al-Muthani, Abdul Salam Mohammed et Al-Salman, Ibrahim Mahdi Azzouz (2007), Practical Environment Field and Laboratory Studies, First Edition, Sabha University Publications, Libye : 407 p.
12- Al-Sahaf, Mehdi (1976). Water Resources in Iraq and their Conservation from Pollution.Ministry of Information.Baghdad.
13- Antoniades, D. and Douglas , M.S.V.(2002). Characterization of high arctic stream diatom assemblages from Cornwallis idland, Nunarut, Canada . Can .J. Bot. 80:50-58.
14- APHA.(2005). American public Health Association , "Standard Methods for the Examination of Water and Westwater". 21st . ed.
15- Cho, K.J.(1991). Spatial and temporal distribution of phytoplankton and periphytic diatom assemblages of Nakdong river estuary. J. phycol.,6(1):47-53.
16- Desikachary. F.R.(1959). Cyanophyta, Acad Press London .
17- Furet, J. E., and K. Benson-Evans. (1982) . An evaluation of the time required to obtain complete sedimentation of fixed algal particles prior to enumeration. Br. Phycol. J., 17: 253-258.
18- Graham, L.E. and Wilcox, L.W. (2000). Algae. Hall, Inc. London .
19- Hamdawi, Ali Obaid Shawat. (2016) Evaluation of the water quality of the Shamiya River / Diwaniya / Iraq / in terms of diatoms PhD thesis college of Education - University of Qadisiyah 32 p.
20- Hassan, Fikrat. M.Rafia, Hadi, Kassim, Thaer. I., and Al-Hassany, Jinan. S. (2012). Systematic study of epiphytic algal after restoration of Al-Hawizah marshes, southern of Iraq. Inter. J. Aquatic Science, 2008-8019.
21- Hustedt, F. (1930). Bacillariophyta (Diatomeae). Susswasser-flort Mitteleuropas,Heft 10: 1-466.
22- Ibanez, J.G.;Esparza, M. H., Serrano, C. D., Infante, A.F. and Singh ,M .M.(2007).Environmental chemistry fundamentals . Springer, New York, USA
23- Janabi Zahraa Zahrao Farhan. (2011) implementation of Water Quality Guides in the Tigris River within Baghdad, Iraq. MASTER Thesis, College of Science for women / University of Baghdad
24- Lind, O. T. (1979). Hand book of common methods in Limnology C.V Mosby, St. Louis :199 pp.
25- Murck, B. W. (2005). Environmental science a self-teaching guide. John
26- Neves, I.F., Rocha, D., Roche , K. F. and Pinto, A. A. (2003). Zooplankton community structure of two marginal lakes of river (Cuiaba)(Mato, Grosso, Brazil With Analysis of rotifer and cladocera diversity. Braz. J. Biol. 63(2):329 -343.
27- Parsons, T. R.; Maite, Y. and C. M. Lalli. (1984) A manual of chemical and biological methods for seawater analysis Pergamon Press,Oxford.
28- Prescot, G. W. (1973) Algae of the Western Great Lakes area . William C. Brown Co, Publishers, Dubuqu, lowa. prescott G.W. (1979) How to know fresh water algae. 3rd ed. William C. Brown co., publishers, Dubuque, lowa. 348pp
29- kasim, Thaer Ibrahim and Ismail, Abbas Murtaza (2002) A qualitative study of non-dytomatic phytoplankton in three different water bodies in central Iraq. Diyala Magazine, Al-fteh, Volume (1)Issue (13): 9-1.
30- Saadi, Ahmed Jawad Nassar. (2013) The biodiversity of the Nawaem and some environmental factors affecting it in the Euphrates River / Central Iraq. MASTER Thesis college of Science – University of Babylon.
31- Shannon, C.E and Weaver , W.(1949). The Mathematical theory of communication . Univ Illinois press , Varbana, 117pp.
32- Tafe ,S. (2009). Microbiology Lecture Notes ,Swan TAFE Printing Service, WA
33- Thakor, F. J.; Bhoi, D. K.; Dabhi, H. R. ; Pandy, S. N. & Chauhan, N. B.(2011) Water Quality Index (w.Q.I.) of Pariyej Lake Dist.Kheda-Gujarat,Current World Environment,Vol.6(2),pp:225-231.