Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.4, No.3, 2014

Monthly Variations of Physico-Chemical Characteristics and phytoplankton species diversity as index of water quality in Euphrates River in Al-Hindiya barrage and Kifil City region of Iraq

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Abstract
The present study was designed to demonstrate the seasonal variations in physico-chemical and biological characteristics of the water in the Euphrates River in Al – Hindiya region and kifil city for a period of nine months from October 2011 to June 2012. Water samples were collected on a monthly basis and analyzed for estimation of air and water temperature, pH,conductivity concentration and salinity, total dissolved solids,dissolved oxygen, alkalinity, total hardness,calcium and magnesium hardness,nitrite, nitrate andphosphorus concentration were also recorded.A total of 167 species belonging to 7 divisions have been identified, including Bacillariophyta (75 species, 7 centrals, 68 panels), Cyanophyta (40 species), Chlorophyta (33 species), Euglenophyta (7 species), Chrysophyta (5 species), Dinophyta (4 species) and Cryptophyta (3 species).Some algal genera dominated mostly in the study such as *Nitzschia, Gomphonema, Cymbella, Synedra, Phormidium, Scendesmus* and *Euglena*. High monthly density of Phytoplankton recorder in station 4 (2942.7 cell×10^3/liter) through December and low monthly density in same station (1.4 cell×10^3/liter) through January.The diversity indices popularly used, including Shannon diversity index (H’), species richness index (SR), the Evennes Index (J), and use Similarity Coefficient included (Sorensen Coefficient Cs, Jaccard Presence JC, Ellenberg Similarity Index (ISE). The correlation between the physico-chemical parameters with phytoplankton density and Taxa have been made. The results obtained are tabulated and discussed.
Key words: Phytoplanktondiversity,physico-chemical parameters, pollution,Euphrates River

1- Introduction

Water is essential for the survival of lifeon earth.With the rapid development in agriculture, mining, urbanization, and industrialization activities, the river water contamination with hazardous waste and wastewater (1) Discharge of pollutants without treatment to a water resource system from domestic sewers, storm water discharges, industrial wastes discharges, agricultural runoff and other sources can have significant effects of both short term and long term duration on the quality of a river system(2), agriculture activities is responsible for chemical and physical alterations such as increased contaminant and nutrient runoff, an increase in suspended solids due to erosion, and changes in discharge and channel morphology (3).

Algae is considered the main causes for plenty of problems in the aquatic ecosystems and they could be harmful by producing many populations in the aquatic environment (4).On the other hand, Algae has long been identified as valuable indicators in the bio- monitoring of stream and river ecosystems (5). Phytoplankton is defined as free-floating unicellular, filamentous and colonial organisms that grow photo-autographically in aquatic environments (6). The quality and quantity of phytoplankton are a good indicator of water quality. The high relative abundance of chlorophyta is an indicator of atrophic conditions (7). Diversity indices are applied in water pollution research to evaluate the effects of pollution on species composition (8). The climate and water quality parameters effect on the biodiversity (9).Few researches have been done on Limnology and biodiversity indices ofPhytoplankton in Euphrates River in the region between Al- Hindiya and Kifil City.The objective of this study was to estimate the physicochemical characteristics and phytoplankton species diversity to evaluate the pollution status of four stations in the Euphrates River.

2- Materials and methods

2.1 Study area description: The present study area was chosen in the mid region of the Euphrates River, between Al-Hindiya regions tokifil city. The four stations were chosen in this area (Figure 1).

2.1.1. First station:Twareej district Al- Mahreq region near new Twareej: bridge which contains sewage water pipes.

2.1.2. Second station: its far (19 km) from the first station, which located through the housing area in Aofi area through Al- Hilla town this station has considered as a location for discharging of filter washing water of new Aofi water treatment station.

2.1.3. Third station: its far (3 km) from the second station through an agricultural area so filter washing water discharge for a Binee sale station in addition to discharge from the neighboring agricultural area.

2.1.4. Four stations: its far (28 km) from a third station in Al –Kifil district, Water treatment plant for the purpose of use in a lab Tires Najaf near Al –Kifil bridge.

2.2 Samplecollection:

Each sampling stations were visited monthly for the period from October 2011 through June 2012, Air and water temperaturewere measured in situ using a thermometer (accurate to nearest 0.1°C),the pH of the samples was recorded using a pH meter (model HANNA).Electrical conductivity, Salinity and TDS were measured, following (10). Dissolved oxygen, total alkalinity,total hardness, calcium, magnesium was estimated following. Nitrite, nitrate and phosphate were estimated following (11). Phytoplankton was collected from the sampling stations with plankton net (12) for qualitative study.Whilefor quantitative study, the phytoplankton population is measured using a sedimentation technique, the micro transect methods were used for counting diatom and haemocytometer methods for other groups.It was identified mainly using the works of (13), (14), (15), (16), (17), (18), (19), and (20).

2.3 Biodiversity indices:

2.3.1. Shannon - Wiener index for estimation the changes in biodiversity of study Phytoplankton, (21).
$H' = -\Sigma (Ni /N) Ln (Ni /N)$, Where,(Ni) are the number and biomass of one species, and N is the total number of individuals of all species.

2.3.2. Species Richness (SR) was calculated as proposed by (22).
$SR = S – 1 / Ln N$,Where, S = the number of species representing a particular sample, N = the natural logarithm of the total number of individuals of all the species within the sample.

2.3.3. Evennessindex for determining the species equivalent, proposed by (23).
$J = H' / Ln S$, Where, H represents theShannon-Wiener index values, and S thenumber of species.

2.3.4. Similarity Coefficient indices: Three different parameters were adapted to makea comparative study between study stations.These parameters were calculated according to (24)and similarity parameters include the following:-

2.3.4.1. Jaccard coefficient, ($JC = C / A + B + C$), Where, a = Number of species in sample a only, b = Number of species in sampleb only, C = Number of species common to both samples.

2.3.4.2. Sorensen stimulator index [$Cs = 2J / (a + b)$], Where, J= Number of species common to both samples, a = Number of species in sample a only, b = Number of species in sample b only.

2.3.4.3. Ellenberg Similarity Index (ISE) =[$(Mc / Ma + Mb + Mc) \times 100$] , Where, Ma= present species density summation in astation A and not present atB station, Mb = present species density summation in b station and not present in a station. Mc = similar species density summation between a and b stations.

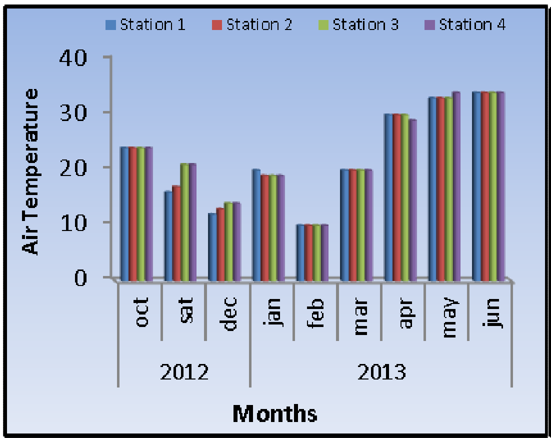
2.4 Statistical analysis:-

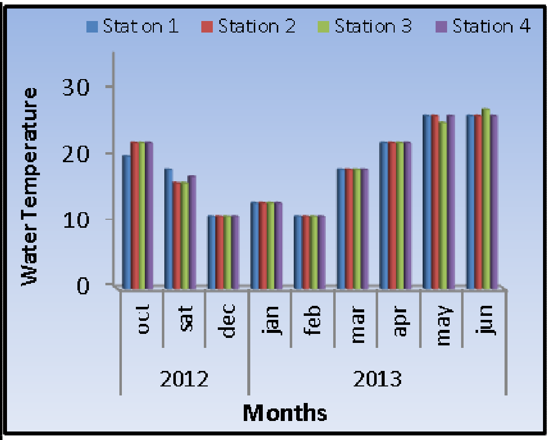
Data were analyzed with the statistical software SPSS 17.0 for Windows (SPSS). The Wilcoxon test for paired data, and the calculation of rank correlation coefficients according to Spearman (rS) were performed. P = 0.05 was considered statistically significant.

3. Discussion:

The physic-chemical factors of different sampling stations are appended in figures (2). The water quality analysis of Al- Hindiya river showed that Station1 washighly pollutedbecause of the influxof sewage and domestic wastes. Stations 2, 3 and 4 were found to be less pollution. Station 2 and 3, also receiving sewage and found in agriculturally area, had lesser pollution load compared to Station 1.

The temperature influences most of the physical, chemical and biological processes, the speed of sedimentation of the suspensions, the speed of some chemical reactions, the regime of the oxygen, the intensity of the metabolic processes of the underwater organisms, etc. (25), The values of temperature at different stations were more or less similar relatively warm during summer and relatively cold during winter.


Station 1 Station 2 Station 3 Station 4
Air Temperature
0 10 20 30 40
oct sat dec jan feb mar apr may jun
2012 2013
Months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Water Temperature
0 10 20 30
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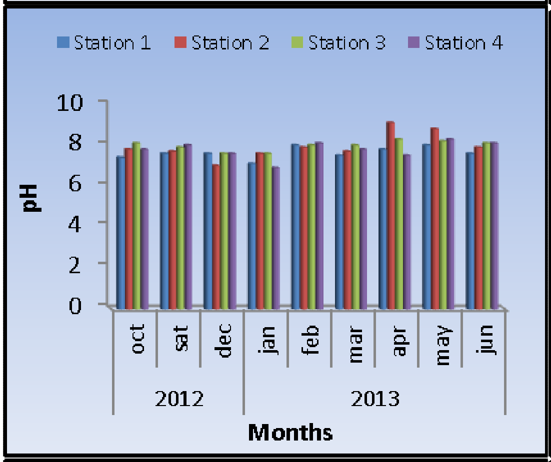
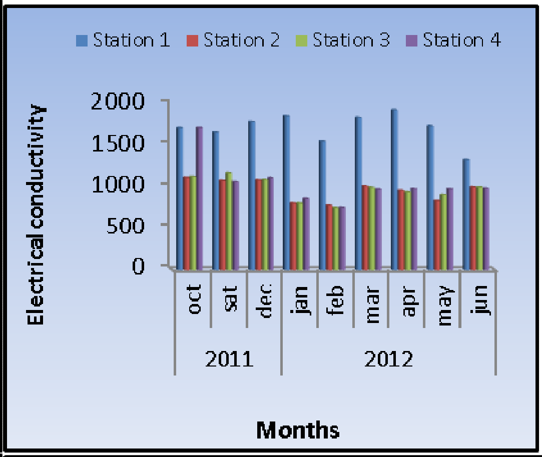
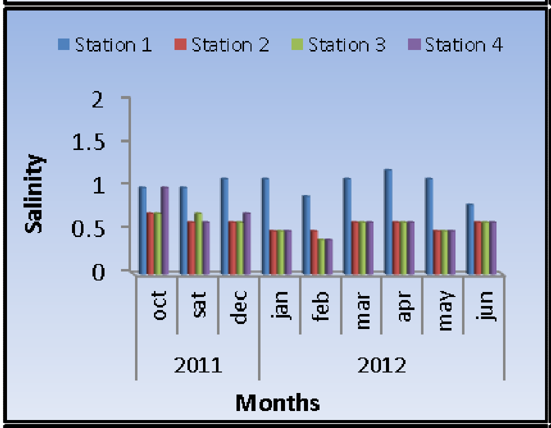
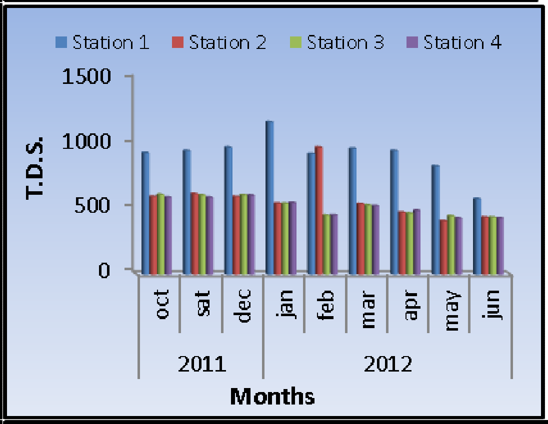
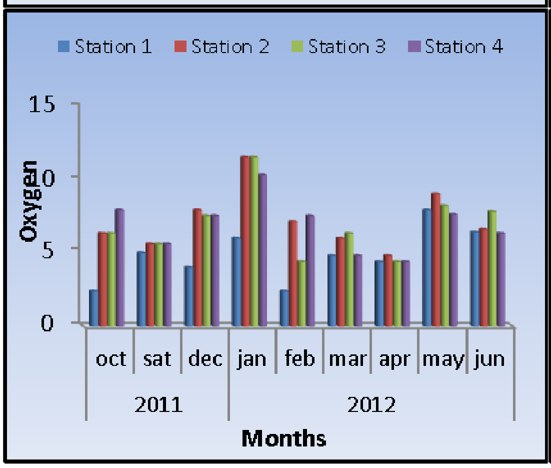
2012 2013
Months

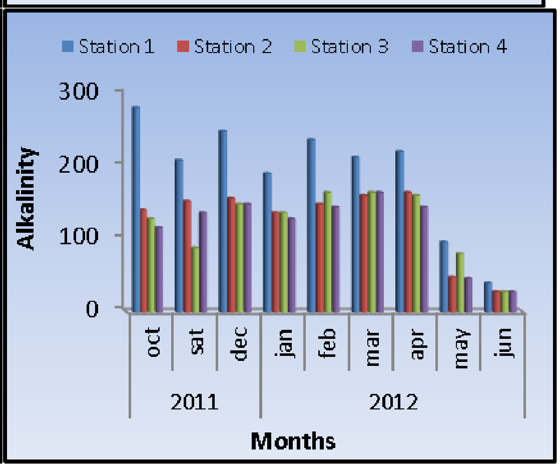

Station 1 Station 2 Station 3 Station 4
pH
0 2 4 6 8 10
oct sat dec jan feb mar apr may jun
2012 2013
Months


Station 1 Station 2 Station 3 Station 4
Electrical conductivity
0 500 1000 1500 2000
oct sat dec jan feb mar apr may jun
2011 2012
Months


Station 1 Station 2 Station 3 Station 4
Salinity
0 0.5 1 1.5 2
oct sat dec jan feb mar apr may jun
2011 2012
Months


Station 1 Station 2 Station 3 Station 4
T.D.S.
0 500 1000 1500
oct sat dec jan feb mar apr may jun
2011 2012
Months


Station 1 Station 2 Station 3 Station 4
Oxygen
0 5 10 15
oct sat dec jan feb mar apr may jun
2011 2012
Months


Station 1 Station 2 Station 3 Station 4
Alkalinity
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oct sat dec jan feb mar apr may jun
2011 2012
Months

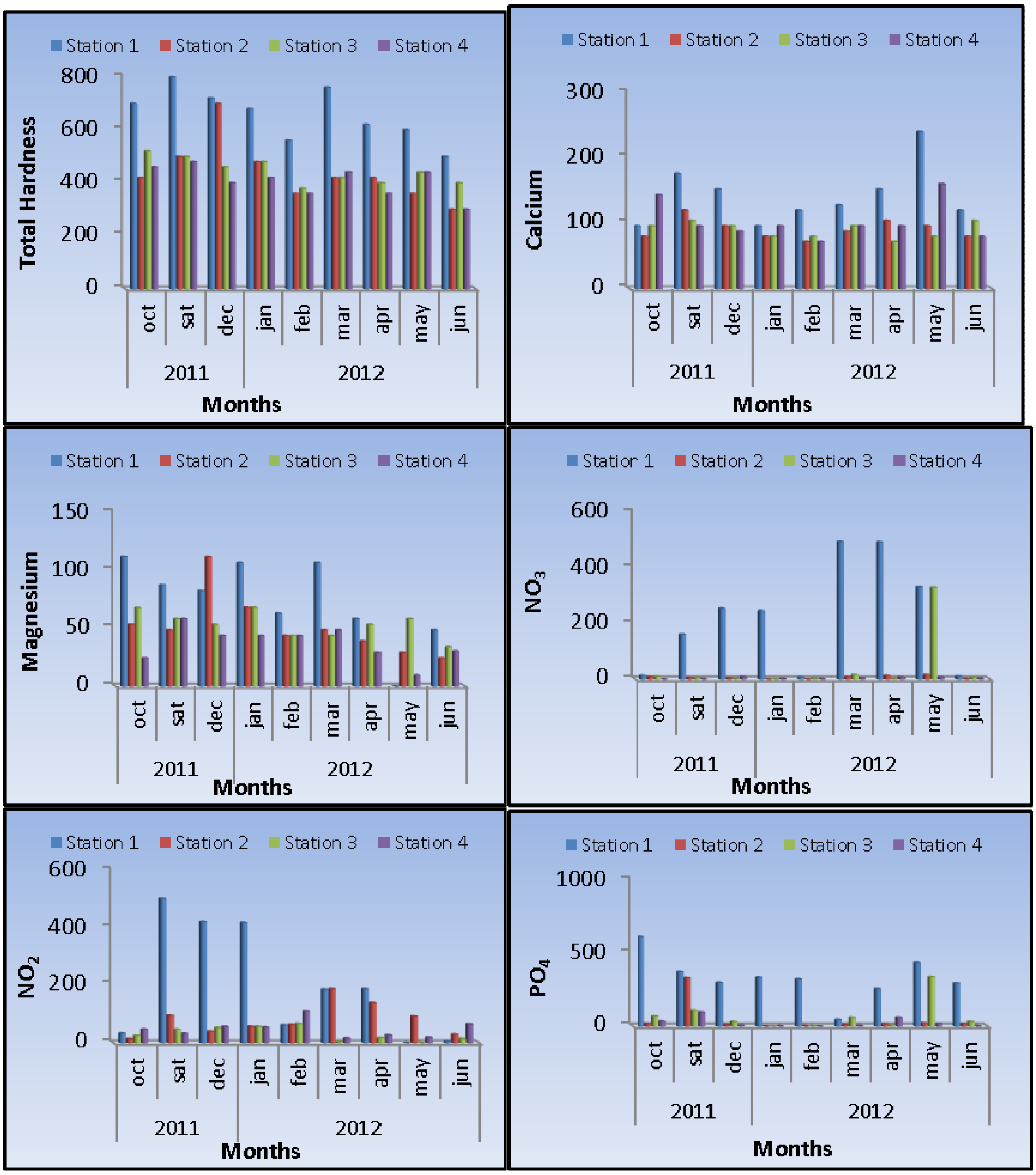

Figure 2: - Monthly variation in physico-chemical characters and total count, total taxa of phytoplankton in Euphrates river between Al – Hindiya region and kifil city.

All stations presented values ranging between (10 ℃) in February and (34 ℃) in June.While the water temperature ranged between (11) in all stations to (26) in station 2 in February and June respectively. On station of sampling, there were recorded low value variations of the samples of water taken.

pH affects the dissolved oxygen level in the water, photosynthesis of aquatic plants, metabolic rates of aquatic organisms and the sensitivity of these organisms to pollution, parasites and disease (26). The pH is controlled by the ratio between the ions of dioxide of carbon, carbonate and bicarbonate. (25). During the investigations, The pH of the water samples in the study area ranged from (6.9) in station 4 in January to (9.1) in station 2 in April, indicating it is over the range of (6.55 to 8.5) set by. WHO, thus the river considers as polluted, where,The pH values in agriculturally influenced streams had a tendency to be higher, possibly related to farming practices and also to the soil type in which agricultural activities are localized. This study recorded low value variations from one station to the other. (27) was observed that pH values are higher during the dry season and may be due to increased photosynthesis blooms of cyanobacteria and other algae in the river resulting in the precipitation of carbonates from bicarbonate.

Electrical conductivity (EC) in natural waters is the normalized measure of the water's ability to conduct electric current. This is mostly influenced by dissolving salts present in the water body (28). The conductivity and salinity of the samples of water presented values ranging between (1923µs/cm) (1.2‰)respectively in station 1 in April to (754µs/cm) (0.4‰)respectively in station 3 in February.The potential sources of pollution, such as industrial, urban waste water, etc., increase the concentration of ions in the water and the conductivity.(25), thus,The increasing values of conductivity and salinity in Euphrates River may be of the discharge of agricultural and industrial wastewater (29).

The solids remaining in water after filtration are called 'total dissolved solids', Dissolved solids may be organic or inorganic in nature (30). Precisely, the dissolved solids are composed mainly of carbonates, bicarbonates, chloride, sulphate, calcium, magnesium, phosphate, nitrate, sodium, potassium and iron (Trivedy and Goel, 1986)(31). Weathering of rocks depends upon the availability of bicarbonates into a given environment and soil beneath the water always contributes to the level of total dissolved solids in water (32).

TDS showed significant differences in their concentrations among the stations, the values ranging between (409 mg/l) in station 2 in May to (1166mg/l) in station 1 in January, this study recorded high values in Electrical conductivity,salinity and total dissolved solids in station1,might be due to the gradual increase in the entry of domestic sewage detergents and waste to the river alkalinity in water provides an idea of natural salts present in the water. The cause of alkalinity is the minerals, which dissolve in water from the soil. The various ionic species that contribute to alkalinity include bicarbonate, hydroxide, phosphate, borate and organic acids (33).

Alkalinity, also results from the dissolution of calcium carbonate ($CaCO_3$) from limestone bedrock which is eroded during the natural processes of weathering. The carbon dioxide (CO_2) released from the calcium carbonate into the stream water undergoes several equilibrium reactions (34).

The values of total alkalinity were ranged 28 mg $CaCO_3$/L at station 2,3and 4 during June and 280mg $CaCO_3$/L in station 1during October.The statistical analysis showed a significant difference between station 1 when compared with other stations.Dissolved oxygen in water is an important factor determining the occurrence and abundance of aquatic organisms, because for all the aquatic aerobes, oxygen is pre-requisite for life, thus the more the oxygen available, the more the organisms are found (35).

It is an important t indicator of water quality, ecological status, productivity and health of a reservoir. This is due to its importance as a respiratory gas (36). Theminimum dissolved oxygen (2.4 mg/ L) was observed at station 1 during February and October andmaximum value (9.1 mg/ l) recorded in station2 during May.The statistical analysis recorded a significant difference of DO concentration in the station1, which received the municipal sewage and domestic waste water, this is the discharges are organic in nature and hence required oxygen for decomposition (37). Or might be due to higher turbidity and increased suspended materials which affected dissolution of oxygen.(36). Hardness is defined as the concentration of multivalent cations. Multivalent cations are cations (positively charged metal complexes) with a charge greater than 1+, They mainly have the charge of +2, These cations include Ca^{2+} & Mg^{2+}, These ions enter a water supply by leaching of minerals within an aquifer (38) Also to the presence of bicarbonate, sulfates, chloride, and nitrates of CA and Mg (1).

Total hardness recorded for Al- Hindiya river ranges between 300 - 800 mg $CaCO_3$/L, where the minimum value presented in station 2 and 4 andmaximum value for station1 in June and November respectively.Ca^{++} and Mg^{++} have vital importance in plants, which photosynthesis in the aquatic environment, Mg^{++} is in the structure of chlorophyll, The concentration of Mg^{++} has a great effect on algae growing in lakes.(39).All the concentration of calcium were higher than the magnesium concentration among most of the study period at all stations, that's probably due to high abilities of calcium ion to react with dioxide carbon more than for magnesium (40). Calcium concentration was ranged (72.1mg $CaCO_3$ / L) for stations 2 and 4 in February and station 3 in April and (240 mg $CaCO_3$ / L) at station 1 in May.Magnesium values were generally less than recorded for the calcium, with range (zero - 111.8mg $CaCO_3$ / L) at station 1 during May and October respectively andmaximum value also presented in station 2 during December. The statistical analysis showed a significant difference oftotal Hardness, Ca^{++}andMg^{++} hardness between station I and other stations.NO_2 in the surface water increased with temperature as nitrifying bacteria became active (41). Nitrite is oxidized to nitrate after entering an aerobic regime. Similarly, plants and microorganisms reduce nitrate into nitrite but nitrite ion is quickly oxidized back to nitrate once it re-enters the water (28).Nitrate is present as a form of nitrogen and a vital nutrient for growth, reproduction, and the survival of organisms (27). Also Natural sources of nitrate are igneous rock, plant decay and animal debris (including fish, wild animals and birds), and discharges from car exhausts. Nitrate stimulates the growth of plankton and water weeds that provide food for fish. (28).The lowest concentration of nitrite recorded was (zero µ g /L) which was obtained from Station 2 and 4 in February and October respectively, but highest concentration was (495.5 µ g /L) recorded from Station1 in March.

The concentration of nitrate was ranged (zero µ g /L) at station 1 and 3 in May and (502.3µ g /L) at station 1 in November. A significant difference was recorded in concentration of nitrite and nitrate between station 1 and other stations.This is may be because much of their input resulted from land drainage and urban runoff. (42). Or higher levels of nutrients are mainly due to the entering of agricultural drain which contains higher level nutrients.(43).And the decrease of concentrations during the end of summer and autumn was maybe due to uptake by phytoplankton (40).

Phosphates are less soluble and less volatile, therefore, phosphates form salts with calcium and magnesium and fall out of solution to accumulate in the sediment, Phosphate ions in natural water exist in solution in its ionized form, as salts, in organic form or as a particulate species. Higher concentration rarely occurs, because after it enters a water system, it will be rapidly taken up by plants and bacteria. (28)

The value ofphosphates ranged between (zero – 435 μ g /L).The lowest value recorded at station 2 and 3 in January and at station 4 in February, but the highest value recorded at station 1in May factors affecting the transparency of water.Higher rates of phosphates could either be as a result of high evaporation (44) or be attributed to laundry activities which take place daily in well-established family or community spots along the river course (45). The analysis shows a significant difference of phosphate concentration in station 1 compared to other stations.

The phytoplankton of the Al- Hindiya river was investigated from October 2011 to June 2012 Samples were taken monthly from 4 sampling stations Table(1). A total of 167 species belonging to 7 divisions have been identified, includingBacillariophyta , Cyanophyta,Chlorophyta,Euglenophyta , Chrysophyta, Dinophytaand Cryptophyta.The greatest species richness was found in the station 4 (81 species) and the smallest was recorded in the station 2 (69 species). The distribution of phytoplankton in the water column is strongly influenced by the physical, chemical conditions of the water, such as light availability, temperature, turbulence, concentration of dissolved oxygen, and nutrients (46).

Table 1:- The average of density summation of phytoplankton in four stations in Euphrates River

No.	***CYANOPHYCEAE***	**St 1**	**St 2**	**St 3**	**St 4**
1.	*Anabaena sp*	20.7	20.7	-	-
2.	*Aphanocapsa sp*	-	20.7	-	-
3.	*Camptylonemopsis minor Desikachary*	-	-	-	62.1
4.	*Chroococcus minor (kuetz)*	-	-	-	20.7
5.	*Chroococcus sp*	-	20.7	20.7	-
6.	*Gloeocapsa polydermatic kutz*	20.7	20.7	20.7	-
7.	*Gloeocapsa quaternata (Breb)*	-	-	-	20.7
8.	*Gloeocapsa sp*	-	-	-	20.7
9.	*Gomphosphaeria aponina (kutz)*	-	-	41.4	62.1
10.	*Gomphosphaeria lacustris Chodat*	-	-	20.7	20.7
11.	*Gomphosphaeria lacustris var gompacta Lmm*	-	-	-	-
12.	*Lyngbya epiphytica hieronymus*	-	20.7	62.1	34.5
13.	*Lyngbya limnetica lemm*	31	-	-	20.7
14.	*Lyngbya sp*	-	-	-	20.7
15.	*Lyngbya taylorii Drouet and Strick Land*	20.7	-	-	20.7
16.	*Merismopedia convolute de Brebisson*	-	20.7	-	-
17.	*Merismopedia glauco (Ehrenb) Naegeli*	-	-	-	20.7
18.	*Microcystis sp*	-	-	-	20.7
19.	*Nostoc sp*	20.7	-	-	-
20.	*Oscillatoria acuta Bruhl et Biswas*	20.7	-	-	-
21.	*Oscillatoria amphigranulata vangoor*	-	-	20.7	-
22.	*Oscillatoria chalybea var insularis Gardner*	-	-	20.7	-
23.	*Oscillatoria hamelii Fremy*	-	-	20.7	-
24.	*Oscillatoria limnetica lemmermann*	2591.6	124.2	20.7	186.3
25.	*Oscillatoria nigroviridis Thwaites ex Gomont*	-	-	-	20.7
26.	*Oscillatoria prolifica (grev) Gomont*	62.1	-	-	-
27.	*Oscillatoria sp*	20.7	-	20.7	20.7
28.	*Oscillatoria tenuis var tergestina kutz*	62.1	-	20.7	-
29.	*Oscillatoria visagapatensis rao,C.B*	-	-	-	20.7
30.	*Oscillatoria willei gardner em . drouet*	20.7	20.7	-	-
31.	*Phormidium corium (Ag.) Gomont*	-	20.7	-	-
32.	*Phormidium fragile (menegh) Gom*	75.9	-	20.7	20.7
33.	*Phormidium retzii (ag) Gomant*	20.7	-	-	-
34.	*Phormidium sp*	20.7	-	20.7	20.7
35.	*Phormidium tenue (menegh)Gomont*	-	51.7	-	-
36.	*Raphidiopsis indica singh*	-	-	-	20.7
37.	*Raphidiopsis sp*	-	-	20.7	-

38.	*Spirolina laxa g.m. smith*	62.1	-	-	-
39.	*Spirolina laxissima west.G.S*	-	20.7	-	20.7
40.	*Synechococcus aeruginosus Nag*	-	20.7	20.7	-
41.	***CHLOROPHYCEAE***				
42.	*Actinastrum hantzschii Lagerheim*	-	20.7	-	-
43.	*Ankistrodesmus convolutes Corda*	-	-	-	20.7
44.	*Carteria cordiformis (Carter) Diesing*	20.7	-	-	-
45.	*Chlamydomonas cieowskiink Schmidle*	-	20.7	-	20.7
46.	*Chlamydomonas dinobryoni g. m. smith*	103.5	2.3	74.5	998.7
47.	*Chlamydomonas globosa snow*	993.6	-	-	-
48.	*Chlamydomonas snowii printz Smith*	20.7	-	-	-
49.	*Chlamydomonas sp*	20.7	-	-	-
50.	*Chlorella sp.*	-	20.7	82.8	41.4
51.	*Closteriopsis longissima lemmermann*	-	-	20.7	20.7
52.	*Closterium sp*	-	20.7	-	-
53.	*Cosmarium meneghianii Brebisson*	-	-	-	20.7
54.	*Dictyosphaerium pulchellum Wood*	-	-	-	20.7
55.	*Echinosphaerella limnetica g.m. Smith*	20.7	20.7	20.7	-
56.	*Eudorina elegans Ehrenberg*	-	20.7	414	207
57.	*Eudorina sp*	-	-	20.7	-
58.	*Golenkinia radiata prescott*	217.3	-	20.7	20.7
59.	*Kirchneriella sp*	-	-	20.7	-
60.	*Micractinium pusillum Fresenius*	-	20.7	-	-
61.	*Pediastrum simplex (meyen) lemmermann*	-	-	-	20.7
62.	*Pediastrum simplex var. duodenarium (Bailey)*	-	-	-	20.7
63.	*Pediastrum sp*	-	-	20.7	-
64.	*Quadrichloris carterioides*	-	-	62.1	-
65.	*Scendesmus acuminatus (Lagerheim) Chodat*	-	-	-	20.7
66.	*Scendesmus arcuatus lemmermann*	-	-	20.7	20.7
67.	*Scendesmus obliquus*	-	-	20.7	-
68.	*Scendesmus quadricauda var. longispina (Chod.)*	-	20.7	20.7	34.5
69.	*Scendesmus quadricauda var. westii g.m. Smith*	-	20.7	20.7	-
70.	*Spirogyra sp*	20.7	-	-	41.4
71.	*Stigeoclonium sp*	-	-	20.7	-
72.	*Tetradron hastatum var. palatinum(schmidle)*	20.7	20.7	31	51.7
73.	*Tetradron sp*	20.7	-	-	-
74.	*Zygnemopsis sp*	20.7	-	20.7	-
75.	***EUGLENOPHYCEAE***				
76.	*Euglena gracilis Klebs*	-	20.7	-	-
77.	*Euglena minuta prescott*	20.7	-	-	-
78.	*Euglena oxyuris var Minor*	20.7	-	-	-
79.	*Euglena spirogyra Ehrenberg*	20.7	-	-	-
80.	*Euglena viridis Ehrenb.*	62.1	-‘	-	-
81.	*Phacus curvicauda Svirenko*	20.7	-	-	-
82.	*Phacus sp*	62.1	-	-	-
83.	***CHRYSOPHYCEAE***				
84.	*Mallomonas acaroides Perty*	-	20.7	-	-
85.	*Mallomonas acaroides var moskovensis (wermel)*	20.7	20.7	-	-
86.	*Mallomonas sp*	20.7	-	20.7	-
87.	*Stipiotccoccus vasiformis Tiffany*	-	-	-	20.7
88.	*Urgolenopsis Americana (calkins) Lemm*	-	-	20.7	-
89.	***CRYPTOPHYCEAE***				
90.	*Chroomonas marina buttner*	20.7	-	-	-
91.	*Chroomonas sp*	20.7	-	-	-
92.	*Rhodomonas sp*	20.7	20.7	20.7	20.7
93.	***DINOPHYCEAE***				

94.	*Ceratium hirundinella (Muell,) Du Jardin*	-	20.7	-	20.7
95.	*Peridinium sp*	-	-	20.7	-
96.	Glenodinium sp.	-	34.6	-	-
97.	*Glenodinium foliocem Stein*	-	-	89.7	124.2
98.	***BACILLARIOPHYCEAE***				
99.	*Centrals*				
100.	*Coscindiscus lacustris Grun*	-	1.7	-	-
101.	*Cyclotella comta(her.) kutz*	-	-	3.4	-
102.	*Cyclotella meneghiniana kuetizing*	8.1	3.4	3.6	12.5
103.	*Cyclotella Ocellata Pantocsek*	667	1.3	18.4	165.4
104.	*Stephanodiscus astrea (Ehr) Grun*	21.5	5.7	13.3	-
105.	*Stephanodiscus hantzschii Grun*	9.2	-	3.4	-
106.	*Stephanodiscus tenuis Hustedt*	-	8.5	5.1	-
107.	*Pennales*				
108.	*Achanthes lanceolata Debrebisson*	-	-	27.2	-
109.	*Achanthes microcephala kutz*	-	-	44.2	-
110.	*Amphora poteus kutzing*	-	-	-	2
111.	*Cocconeis diminuta Pantocsek*	10	8.5	5.1	23.8
112.	*Cocconeis pediculus Ehernberg*	22.5	1.3	1.7	148.7
113.	*Cocconeis placentula Ehernberg*	39.7	45.7	18.8	49
114.	*Cocconeis placentula var. lineate Ehernberg*	-	2.3	-	1.7
115.	*Cymatopleura elliptica (Berb)W. Smith*	-	-	-	1.6
116.	*Cymatopleura solea (Berb)W.Smith*	-	3.9	5	2
117.	*Cymbella cistula (hempricin) Grun*	-	-	-	1.5
118.	*Cymbella cymbiformis (ktz) Van Heurck*	-	3.9	20.4	-
119.	*Cymbella Helvetica variete curta kutz*	-	3.6	18.7	4
120.	*Cymbella lanceolata (Ehr)*	-	-	20.4	-
121.	*Cymbella sp*	-	1.7	-	2.3
122.	*Cymbella tumida (Berb) Van Heurck*	-	1.7	6.8	-
123.	*Cymbella tumidula Grun*	-	5.1	-	2
124.	*Diatoma elongatum (Lyngb.) Grad ha.*	6	-	-	-
125.	*Diatoma hiemale Var. mesodon (Ehr)*	1.8	6.1	8.2	2
126.	*Diatoma vulgare Bory kutz*	-	11.9	6.6	2
127.	*Diploneis ovalis (Hilse) Cleve*	-	-	11.9	-
128.	*Diploneis pseudovalis Hust.*	-	-	-	2.7
129.	*Eunotia pectinalis variete undulate (Ralfs) Rabenhorst*	-	-	-	3.5
130.	*Eunotia sp*	-	1.5	5.5	10.8
131.	*Frustulia vulgaris Thwaites*	-	-	1.4	-
132.	*Fragilaria crotonesis kitton*	-	-	-	6
133.	*Fragilaria intermedia Grun*	-	-	-	-
134.	*Fragilaria sp*	7.7	1.7	8.5	-
135.	*Gomphonema abbreviatum Ehr*	-	-	-	1.5
136.	*Gomphonema acuminatum Ehernberg*		1.7	6.8	-
137.	*Gomphonema angustatum (kutz) Rabh*	3.3	6.8	5.1	3.2
138.	*Gromphonema constrictum variete capitata (Ehr)*	1.9	-	-	6.9
139.	*Gomphonema gracile (Ehr.)*	-	-	-	2
140.	*Gomphonema sp*	1.9	1.3	-	2
141.	*Gomphonema tergestinum (Grun) Frick*	1.4	-	-	-
142.	*Gyrosigma spencerii (w.smith) Oleve*	-	-	-	6
143.	*Melosira ambigua O.muller*	59.7	5.3	12.2	25.2
144.	*Meridion circulare Agardh*	1.7	-	-	-
145.	*Merdion sp*	1.8	-	1.4	-
146.	*Navicula anglica Ralfs*	-	-	3.4	2
147.	*Navicula cyprinus (Ehrenberg) W . Smith*	-	-	2.6	2
148.	*Navicula halophilia (Cleve) Grun*	6.6	4.7	190.4	-
149.	*Navicula pseudohalophilia Cholnok*	1.8	-	-	3

150.	*Neidium affine (Ehr)*	6.2	3.9	2.1	2.7
151.	*Nitzschia acuta Hantzsch*	-	5.1	-	-
152.	*Nitzschia apiculate (Gregory) Grun*	1.7	-	2.6	-
153.	*Nitzschia frustulum var subsalina*	-	3.8	-	-
154.	*Nitzschia hantzschiana Rabh*	4	-	-	2.7
155.	*Nitzschia linearis w. (Smith).*	-	-	30.6	-
156.	*Nitzschia littoralis Grun*	9	3.9	10.2	-
157.	*Nitzschia longissima (Brebisson) Ralfs*	1.8	1.3	-	3.3
158.	*Nitzschia microcephala Grun*	1.8	-	8.4	-
159.	*Nitzschia palea (ktz).w. Smith*	6	3.9	11.5	-
160.	*Nitzschia sigma (ktz).w. Smith*	-	7.5	2.6	-
161.	*Nitzschia sp.*	-	5.2	-	-
162.	*Nitzschia stagnorum Rabh.*	3.6	-	-	-
163.	*Nizschia umbonata (Ehr)*	5.2	5.1	3.9	-
164.	*Nitzschia vermicularis (ktz.) Hantzsch*	-	-‘	5.1	-
165.	*Raphoneis amphiceros Ehrenberg*	2.3	-	-	3.5
166.	*Rhoicosphenia curvata (ktz.)Grunow*	6.9	-	-	3.3
167.	*Surirella ovalis Debrebisson*	-	2.6	-	2
168.	*Surirella ovata (kuetz.)*	-	2.1	-	2.7
169.	*Surirella sp*	-	1.3	-	2
170.	*Synedra acus (kuetz)*	2.8	3.5	1.3	1.7
171.	*Synedra capitata Ehr*	-	-	-	8.1
172.	*Synedra parasitica variete subconstricta W.S Smith*	-	3.9	-	-
173.	*Synedra sp*	6.6	-	3	5.7
174.	*Synedra tabulate Agaradh (kuetz.)*	-	-	1.4	-
175.	*Synedra ulna (Nitzs.) Ehrenberg*	2	5.6	9.4	12.1

In the present study the river water showed a higher number of species of diatoms(75 species, 7 centerales , 68 pennales), with the higher dissolved oxygen through the study period, in general, the requirement of dissolved oxygen for growth of many diatom species is well documented (47). Pennales diatom was the dominated group of diatoms in the present study, this might be due to high tolerance to wide environmental changes (48), (49), (50).Among which are Nitzschia, Gomphonema, Cymbella and Synedra with (14 , 7, 7, 5 species) respectively, while Fragillaria, Navicula and Cocconeis represent with 4 species. These communities play an important role as primary producers in aquatic ecosystems. They have been extensively used as indicators of environmental change, e.g eutrophication, acidification, salinification, sea level change and land use change, because they have narrow optima and tolerance for many environmental variables (51) (52) reported that the species of Amphora, Cocconeis, Cymbella, and Navicula were common in calcareous and slightly alkaline watersSpecies of the genus Nitzchia are found in a wide range of this study, were known to be important indicators of organic pollution and high nutrient loads which makes them significant for water quality studies and biomonitoring (53), (54). (37) or may indicate organic enrichment in the river (55) ,Navicula halophilia appeared to be indicative of high levels of high-pollution in station 1, syndera ulna recorded the majority of species in station 2,4, while melosira ambigua was found in nutrient rich environments in station 2 ,3,4 .

The blue-green algae represented by (40 species) most rich genus is *Oscillatoria* with (11 species) , , (5 species) from *Phormidium* ,(4 species) from *Lyngby* ,(3 species) from*(Gloeocapsa , Gomphosphaeria*),(2 species) from (*Chroococcus ,Merismopedia ,Raphidiopsis* and *Spirulina*), and only one species denoted for (*Anabaena , Aphanocapsa , Camptylonemopsis ,Microcystis , Nostoc , Synechococcus).*According to (56), some species of the genera *Oscillatoria, Merispopedia, Chroococcus,* etc. (Cyanophyta) are the main species indicating the pollution (25).The species *Oscillatoria limnetica* recorded in high density in station 1for most months, especially in May and June. The algae like *Microcystis aeruginosa* was signified in station 4 used as the best single indicator of pollution and it was associated with the highest degree of civic pollution (57) .More blue, green species were identified in comparison to green species may be due to their higher tolerance to salinity (58) They have found that cyanophyceae are also highly tolerant organisms and prefer to grow at slightly alkaline conditions. (59) (60) notified that Cyanobacteria grow in eutrophic waters and on organically polluted sediment in summer and autumn(61). Domination of cyanobacteria is due not to the low temperature, but to the high concentration of the organic substances in water, (62)(63)(64) suggest that cyanophyceae grow luxuriantly with great variety and abundance in ponds rich in calcium.Whether it plays its role individually or in combination with other factor complexes,Besides calcium, high amounts of oxidizable organic matter, traces of

dissolved oxygen, considerable amounts of nitrate and phosphates in all the effluents investigated were probably the factors favoring the growth of cyanobacteria as suggested by(65).
The predominance of Cyanophyta was due to the high N and P content, but Cyanophyta and Chlorophyta predominated with high nitrogen content of the water (66). The physical and chemical characteristics are favorable a specific diversification of Chlorophyta. Indeed the Chlorophyta are typically thermophilous and photophilic (67). Species of chlorophyta were recorded onthe Al Hindiya river, Chlamydomonas, Scendesmus with (5) species was the dominant genus, which was followed by Pediastrum (3), Eudorina, Spirogyra, Tetraedron (2), and one species for another type of Chlorophyta.An interesting feature was the relatively high number of Chlamydomonas dinobryoni especially in the station I in October and December, and Chlamydomonas globosa at the same station in February,(68) have concluded that Chlamydomonas is an attractive system for nitrate assimilation in photosynthetic eukaryotes. The green algae furthermore represented by Scenedesmaceae (mostly Scenedesmus spp),and one species for pediastrium ,cosmarium . These three genus may be abundant in eutrophic waters (69).Euglenophytas form a group related to contamination with organic matter, and a qualitatively well represented group in lentic environments., and they are subjected to the anthropogenic influence, revealing that they are good indicators of water quality (70) (71) concluded that, organic matter within domestic sewage discharge give a suitable medium for the growth of Euglenophyta. (72) recorded great growth of Euglena in organically polluted bodies of water in this study, Euglenophyta spp. Were largely present at station 1(6 species)(4 Euglena ,2 Phacus) and also one specie (Euglena gracilis)present at stations 2. Euglenophyta are more abundant in polluted water and in water rich in organic matter (73) Chrysophyceae was represented by five species,3 species from (Mallomonas),and one species from (Stipitococcus, Uroglenopsis), Dinophyceae was signified by 4 species, among which are (Glenodinium, Ceratium, Peridinium) with (2,1,1) respectively. Only three species from Cryptophyceae (2 species Chroomonas, 1species Rhodomonas) was identified in Al-Hindiya river.The percentage occurrence of different phytoplankton groups at four different stations of Al -Hindiya River throughout the study has been given in Figure (3).

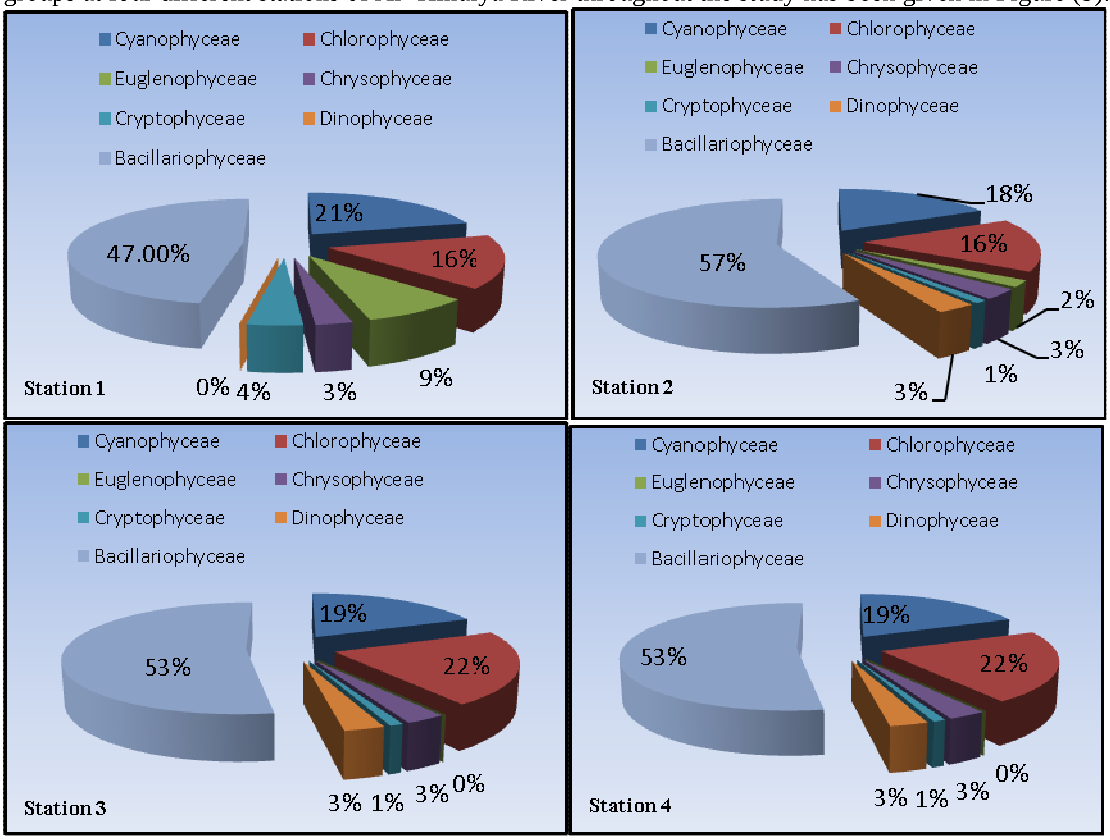

Figure 3:- Phytoplankton compositions of each division in four stations on Euphrates river

The density and number of Phytoplankton recorder in four stations are appended in figure (4). High monthly density of Phytoplankton recorder in station 4 (2942.7cell×10^3/liter)through December and low monthly density in same station (1.4 cell×10^3/liter)through January .During the study period,The high density of phytoplankton present at station 1and 4 might be due to availability of environmental condition for phytoplankton growth,or can be explained by the increase of nutrients in the environment (74), proposes that a high density of phytoplankton recorded for this stations may be associated with nutrients and low water current before Al-Hindiya river. And it was found that water temperature strongly regulates the seasonal variations of phytoplankton (75) the lower phytoplankton abundance is related to the low concentration of mineral food components (first of all, of phosphorus) and to the alga photo-inhibition in the surface layers (76).

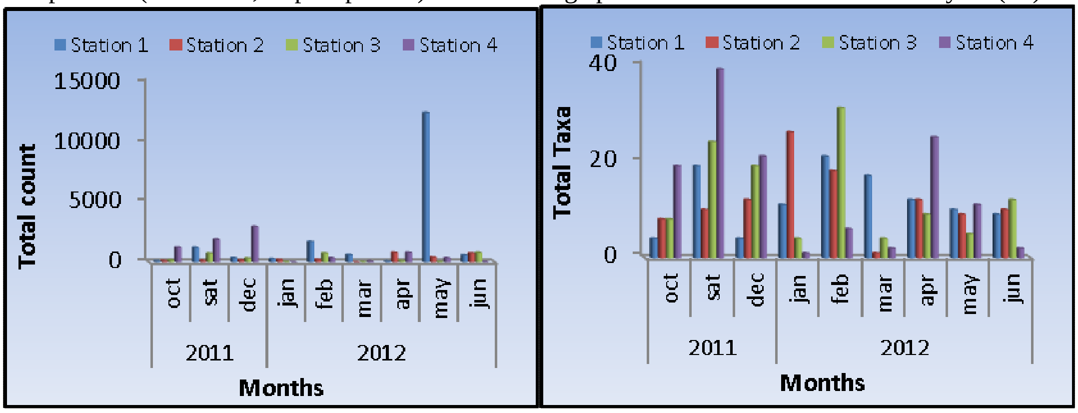

Figure 4:- Phytoplankton density and numbers in four stations of Euphrates River.

In this study, the diversity indices popularly used, including Shannon diversity index (H'), species richness index (SR),the Evennes Index (E)was presented in tables (2).

Table 2:- Values of species diversity indexes in Euphrates river

Stations	**Shannon-Wiener index**	**Richness Index**	**Evenness Index**
Station 1	**1.02**	**7**	0.2
Station 2	**3.3**	**9.1**	0.7
Station 3	**3.2**	**9.5**	0.7
Station 4	**2.2**	**8.9**	0.5

and use Similarity Coefficient included (Sorensen Coefficient Cs, Jaccard Presence JC, Ellenberg Similarity Index (ISE)appended in Tables (3)., were considered as explanatory variables of eutrophication levels, and reflected changes in the phytoplankton community structure in the river.

Table 3:- Sorensen Coefficient, Jaccard'scoefficients and Ellenberg Similarity Index showing similarities between the four stations.

Stations	**Sorensen Coefficient**	**Jaccard's coefficients**	**Ellenberg Similarity Index**
1.2	**1.4**	**55**	83.6
1.3	**0.8**	**92**	82.5
1.4	**0.6**	**23**	86.3
2.3	**1**	**33**	76.7
2.4	**0.8**	**28**	83.5
3.4	**0.8**	**29**	81.6

Shannon-Weaver index values of phytoplankton communities can be used to indicate water pollution status(77).. Values of less than 1 are interpreted as heavily polluted, 1-3 as moderately polluted and more than 3 as clean water (78). The Shannon-Weaver index of the Al Hindiya river varied from 1.02 to 3.3, suggesting that the water quality should be classified as moderately polluted. The highest value in station 2 and 3 whilst the lowest value in station 1, so Most of the rivers are not affected by human activities, The impact of man on the water bodies is basically caused by the discharge of domestic and agricultural waste water rich in nutrients. The increase of anthropogenic effect leads to slightly increased bottom species diversity and structural trivialization, followed by a decline in the number of dominant species. The values of Richness index were ranged (9.5- 7), thehighest value in station2 and 3,whilst the lowest value in station 1, Evenness Index wereranged (0.2-0.7),the highest value in station 2 and 3 and low at station 1. The high diversity indexes in station 2 and 3 may be attributed to the lack of pollution in this region and this is consistent with the conclusion drawn by (79) who suggested that pollution would lead to reduce the diversity index. For the four stations during the 9 month study. The lowest Jaccard's coefficient (23) was recorded between stations 1 and 4 throughout the study. The highest coefficient of (92)was recorded between stations 1 and 3. The highest Sorensen coefficient (1.4) was recorded between stations 1 and 2, whilstThe lowest Sorensen coefficient (0.6) between stations1 and 4.The Ellenberg Similarity Index was recorded highest coefficient (86.3) between stations 1and 4, the lowest Similarity value (76.7) between stations 2and 3.

Correlationcoefficients were estimated between phytoplankton density and Taxa with physico-chemical parameters of waterTable (4).phytoplankton density showed positive correlation with salinity ,Calcium and Magnesium .The positive correlation of some water properties with phytoplankton density may be due to playing a pivotal role in regulation various biological activities and growth(80). also showed Phytoplankton appeared to be negatively correlatedwith inorganic N, PO4-P and DO, which is mainly becauseof eutrophication in the waters of the River(81) alsoPhytoplankton consume phosphate and inorganic forms of nitrogen in their metabolic activity at different times, thus showing negative correlation. It may be concluded that the density of phytoplankton is dependent on different abiotic factors either directly or indirectly (30).

Table 4: - The correlation coefficient values among certain physico-chemical parameters of River from October 2012 to June 2013:-

Pahysico-chemical characteristic	**Total Taxa**	**Total Number**
Temperature of Air	-.263	.161
Temperature of water	-.267	.175
pH	.032	.083
Electrical conductivity	.008	.298
Salinity	-.014	.334*
T.D.S.	.075	.175
Oxygen	-.123	.064
Alkalinity	.071	-.103
Total Hardness	.027	.143
Calcium	.024	.669**
Magnesium	-.043	.745**
NO3	-.077	.274
NO2	-.028	-.111
PO4	-.104	.319

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

4. Conclusion:

The present study concluded that physic-chemical and phytoplankton characteristics of Al- Hindiya river showed monthly variation. A total of 167 species belonging to 7 divisions have been identified belonging to three families of Bacillariophyceae,Cyanophyceae Chlorophyceae, Euglenophytceae, Chrysophyceae, Dinophytceae and Cryptophytceae,the low values ofShannon diversity,species richness and Evennes indexes were recorded in the station 1. The phytoplankton showed a positive significant relation with transparency, conductivity, pH, total hardness and DO. The high value of the phytoplankton diversity at both the sites indicates good physicochemicalconditions of the river. Thus the water quality of river Tons was fairly good for the growth and survival of phytoplankton.

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