Plant Archives Vol. 18 No. 2, 2018 pp. 2285-2291 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

SEASONAL STUDY OF SOME PHYSICAL AND CHEMICAL FACTORS AND ALGAE IN THE TIGRIS RIVER, BAGHDAD-IRAQ

Amin Abooud Kbin Al-Ghafily*

Depart. of Biology, College of Education for Pure Science (Ibn Al-Haitham), University of Baghdad, Baghdad, Iraq

Abstract

Three sites in Tigris River were selected to collect water and algae samples seasonal during the period from (December 2013-October 2014) for the purpose of identifying seasonal changes to physical and chemical factors and the favourite seasons of algae presence. Air temperature ranged from 21-41°C and water (15.3-25.8)°C. The Tigris river water was described as alkaline (7-8.3) and the total alkaline (96-181) mg $CaCO_3$/L. The electrical conductivity values (1226-2436) µsem/cm. The dissolved oxygen also appeared not to have dropped from 3.9 mg/L throughout the study period, total hardness, calcium and magnesium recorded values (292-452), (97-136), (43-81) mg $CaCO_3$/L, respectively, Sacchi disc readings (61-98) cm and the salinity values did not decrease from 0.61%. Plant nutrient values (0.31-1.06) µgm/L for nitrate, (0.002-0.008) µgm/L for nitrite, (105-178) µgm/L for silica and (0.17-1.41) µgm/L for phosphate. (49) species of algae were diagnosed in (29) genus; it was observed that their growth in spring and autumn was more than two other season, revealed through this study that the presence of chlorophyceae in the spring is more than other season. While the presence of the cyanophyceae algae were distinct in autumn, the Bacillariophyceae class were filled with the highest numbers of 28 species.

Key words: Tigris River, chlorophyceae, Bacillariophyceae, cyanophyceae.

Introduction:

The Tigris River is one of the important rivers in Iraq and has a length of (1718) km of its origin up to its estuary (Sahaf, 1976). The diagnosis of algae and determinate of their number in any water surface shed light on the state of that surface in terms of water quality. A study of (Abdin *et al.*, 1957) is the first studies on the distribution of algae in and around Baghdad and Basra. Then came a study Al-Kaisi (1976) to illustrate the algae present between Baghdad and Basrah as well. In the last two decades of the twentieth century, many studies were carried out on the Tigris River, including a study of Nurul-Islam *et al.* (1982) algae in the Al-Rashidiya reservoir in Baghdad city, and the study Saadallah (1985) about the effect of the Al-Saqlawiyah district in the Tigris River. As well as study Maoulood *et al.* (1994) about the Tigris River before and after Baghdad city, and Al-Lami *et al.* (1999) limnological study on the Tigris River between Mosul and Al-Kut city.

Studies in the 20th century continued to be studied Al-Kubaisi *et al.* (2001) on the Tigris River before and after its passage in Baghdad city, and Al-Kubaisi *et al.* (2001) explained the domains of the Diatoms on the rest of the algae totals. Al-Khalidi (2004) was examined the difference in the levels of the Tigris River's scraps on the changed of the biological environmental system between the Muthanna Bridge and the estuary of the Diyala River, and Al-Shindah (2008) studied some of the physical and chemical qualities. Al-Janabi (2011) was indicated in its study of some of the physical and chemical characteristics of the Tigris river waters within the city of Baghdad to examine and apply water quality guides in the river and showed that the river water is good for irrigation. Additionally, Al-Dulaimi (2013) was studied the environment and diagnosis of algae in the Tigris River for Al-Dhuluiya city and their surroundings and found that the water in these area tending to the alkaline, and finally a study of the Al-Maqdmi (2016) about algae community in the Tigris River between Baghdad and the Al-Dujail region.

Material and Methods

Three sites were selected on the Tigris River (fig. 1), a season sample was collected from December (2013) and up to October (2014), measured air and water temperature in the field directly using the mercury

***Author for correspondence :** E-mail : ameen.abbood@gmail.com

temperature, and the light penetration is calculated by Sacchi disc, pH is measured directly at the study site using the pH-meter model pH 90, and the electrical conductivity is measured in the study sites using the conductivity meter model LF 91, and to calculate dissolved oxygen it has followed the Winkler method (APHA. 2005). The values of salinity have been calculated according to the Kundson formula that have described by APHA (1976) based on chloride values and to measure the total hardness, calcium, magnesium, and total alkalinity was based on APHA (2005). For the measurement of plant nutrients, nitrite (NO_2) has been calculated using the method described by Parsons *et al.* (1984), and the nitrate (NO_3) has followed the method described by APHA (2005). Silica was calculated using the method described by APHA (2005) and phosphate by following method Parsons *et al*. (1984). The algae collected the samples of phytoplankton using the phytoplankton net with diameter pore 55 µm where the net reflex of water direction for a period of (15-20) minutes, and the contents of the net were collected in small bottles for the purpose of laboratory testing, then was added Logel solution which prepared by relying on Prescott (1979) into the samples. Non-diatoms algae are diagnosed by depend on the following sources Prescott (1973); Prescot (1982), Bold and Wyne (1985), Desikachary (1972) and Hoyos and Vega (2000). Algae Bacillariophyceae (diatoms) have depend on the following sources Hadi *et al*. (2084); Patrick and Reimer (1975); Germain (1981) and Munir *et al.* (2012).

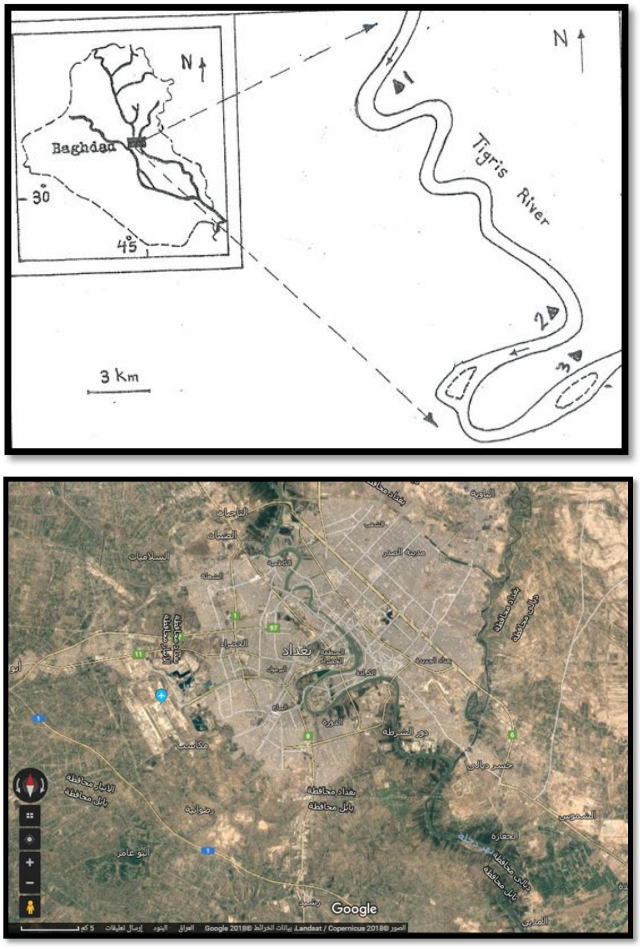

Fig. 1: The map of Iraq show the sampling station on Tigris River

Results and discussion

Chemical and physical factors

The air temperature ranged from (41)°C up to the third station during the summer and (21)°C at the first station during the winter, and that the few differences in air temperature between stations are due to sampling time and their results have shown seasonal variations in their rates. While water has been affected by air temperature and the relationship between them was extreme and the highest temperature (26.1)°C was recorded at the third station during the summer and at least (15.3)°C at the second station during winter, the temperature of the water follows the time period and the environmental conditions in situ. The water of the studied stations was characterized as being alkaline, no seasonal changes were observed and pH values ranged from 8.3 in the second station during summer and (7) for the same station in spring maybe the reason for the rise of pH in summer is due to the blooming growth of some algae that consume CO_2 of water by photosynthesis which leading to higher pH values (table 1).

The highest value of the total alkalinity (181) mg $CaCO_3$/L was found in the first station during the winter and at least (96) mg $CaCO_3$/L at station three during the autumn, it was observed that the total alkalinity values increased in winter and gradually decreased in the spring, summer and autumn seasons due to carbonate deposition at high temperatures that leading to the lowering of the total alkalinity (Al-Dulaimi, 2013).

The total values of hardness ranged from (215-452) mg/L, and the river water is considered to be very hardness according to global divisions. The rise of total hardness values in winter at all stations may be due to rainfall and the erosion of soil of a calcium nature, increasing the water hardness (Al-Janabi, 2011). Calcium is the most common among the dissolved positive ions in the water and is an essential ingredient of flora and fauna (Muthani,and Salman 2007) and recorded the highest value of Calcium (136) mg/L at third station during summer and at least (96) mg/L at second station during winter, and generally observed a drop of its concentrations during winter. Magnesium comes after calcium in that it

Table 1: Physical and chemical factors of the stations studied

No	Name and number of Station	Al-Muthanna bridge (1)				Al-Jadiriyah (2)				Al-Za'faraniyah (3)			
	Season / Measured factor	winter	Spring	summer	Autumn	winter	Spring	summer	Autumn	winter	Spring	summer	Autumn
1-	Air Temperature C°	21	27	39	32	22	27	39	33	22	27	41	33
2-	Water Temperature C°	15.6	18.3	25.2	21	15.3	18.5	25.8	21.8	15.4	18.9	26.1	21.3
3-	pH	7.1	7.7	7.9	73	7.8	7	8.3	8.1	7.6	7.5	8.1	7.2
4-	Conductivity (µsem/cm)	1815	1623	1933	1850	1226	1418	1817	1653	1918	1530	2463	1904
5-	Total alkalinity (mg $CaCO_3$/L)	181	167	163	122	175	179	157	131	168	175	141	96
6-	Dissolved oxygen (mg/L)	8.8	7.8	4.2	61	10.2	8.9	4.5	7.2	8.2	7.4	3.9	6.5
7-	Total hardness (mg $CaCO_3$/L)	452	398	357	371	366	321	306	345	415	324	388	336
8-	Calcium (mg/L)	102	97	116	112	96	105	121	118	112	119	136	122
9-	Magnesium (mg/L)	57	59	69	61	43	52	57	52	51	61	81	68
10-	Salinity ‰	0.73	0.82	0,93	0.78	0.62	0.75	0.91	0.64	0.79	0.73	1.02	0.87
11-	Secchi disc (cm)	77	81	69	90	75	87	98	93	81	82	79	61
12-	NO_2 (µg NO_2. N/L)	0.005	0.006	0.002	0.004	0.008	0.007	0.003	0.006	0.003	0.004	0.002	0.005
13-	NO_3 (µg NO_3. N/L	0.42	0.51	0.66	0.51	0.41	1.06	0.51	0.78	0.34	0.37	0.31	0.4
14-	SiO_3 (µg SiO_3. Si/L)	141	115	157	135	161	128	173	144	178	118	105	146
15-	PO_4 (µg PO_4. P/L	0.56	0.98	0.35	1.12	0.49	0.17	1.41	0.78	0.51	0.31	0.75	0.41

is the most important positive base ions found in the water and the clay minerals are a source (Lind, 1979). The highest concentration of magnesium (81) mg/L was recorded in the third station during the summer and at least (43) mg/L at the second station during the winter. The increase in magnesium values may be due to the low land and the many farms that reach the excess water from the irrigation to the Tigris River as well as the waters of puncture land on both sides of the river.

The highest rate of light penetration values (98) cm was recorded in the second station during the summer and the lowest (61) cm in the third station during the autumn, and the rise in the penetration values may be due to low flux speed, which has helped to sedimentation of the suspended materials, while high water levels in the autumn helped to drift the edges clay in the third station, resulting in lower penetration values. The penetration of the light depends on the purity of the water and its content from algae and organic pollution (Maulood *et al.*, 1990). The electrical conductivity values ranged from (1418-2463) µsem/cm in the second and third stations respectively, and the electrical conductivity numerical value refers to the ability of the water to carry the electric current and depends on the temperatureand concentration of existing salts and ions. Salinity ranged from (0.62)% in the second station during the winter and (1.02%) in the third station during the summer, the rise in summer is probably due to lower water levels, higher temperatures and increased evaporation.

Dissolved oxygen in water is one of the determinants of productivity in most environments and its quantity indicates water cleanliness (Maulood *et al.*, 1990). The dissolved oxygen values ranged from (10.2 mg/L in the second station during the winter and (3.9) mg/L in the third station during the summer, and found that the value increases in winter and declines in summer (Al-Asady, 2015). The depreciation of the warm and hot months is due to the activity of the oxygen-consuming micro-organisms, and the low and slow-moving water levels play an important role in lowering its level (Al-Kubaisi *et al.*, 2001).

Nitrate is one of the nutrients needed by aquatic plants, especially algae, for growth and reproduction, and silicate and phosphate are specific to the growth of the Daitomes (Gilpin *et al.*, 2004). The highest concentration rate of nitrate (1.06) µgm/L was recorded at the second station during the spring and at least (0.31) µgm/L at the third station during summer. The rise of nitrates during spring is due to the increase water levels at spring as well as reach to the river from agricultural residues (Al-Tamimi, 2006). The values of nitrite (0.008) µgm/L in the second station during the winter and (0.002) µgm/L in the first station during the summer. The higher nitrate values in winter at most stations is due to increased rainfall, high water levels and the fluxes of arable land rich in nitrogen compounds that is an essential ingredient in the synthesis of fertilizers, that the nitrite is unstable, so the concentration of nitrate is mostly low in well-ventilated water (Reiol, 1961).

The concentrations of the silica ranged between (178)

Table 2: A list of the names of the algae that are diagnosed in the waters of the Tigris River.

No	Name and number of Station	Al-Muthanna bridge (1)				Al-Jadiriyah (2)				Al-Za'faraniyah (3)			
	Season / Taxa	winter	Spring	summer	Autumn	winter	Spring	summer	Autumn	winter	Spring	summer	Autumn
	Cyanophyceae												
1-	*Chroococcus dispersus* (Keissl) Lemmermann	+	+		+	+	+		+	+	+		
2-	*Coelsphaerium* sp.			+	+	+			+	+			+
3-	*Merismopedia elegans* A. Braun			+		+	+		+	+			+
4-	Microcystis sp.				+		+		+				
5-	*Oscillatoria ornata* (Ktz.) Gomont	+			+				+		+		
6-	*O. princepes* Vaucher	+	+	+	+	+	+	+	+	+	+	+	+
7-	*O. tenuis* Agardh								+				
8-	*Phormidium* sp.				+					+	+		+
9-	*Spirulina* sp.	+			+				+				+
	Total	**4**	**2**	**3**	**7**	**4**	**4**	**1**	**8**	**5**	**4**	**1**	**5**
	Chlorophyceae												
10-	*Chlorella ellipsoidea* Gerneck	+	+	+			+				+		
11-	*Crucigenia quadrata* Moren		+		+		+				+		
12-	*Mougeotia* sp.	+			+			+	+			+	+
13-	*Oocystis elliptica* West		+			+	+			+	+		
14-	*Pediastrum boryyanum* (Trup.) Meneghini	+	+	+	+	+	+	+	+	+	+	+	+
15-	*P. simplex* Meyen	+	+	+	+	+	+	+	+	+	+	+	+
16-	*Sphaerocystis* sp.	+			+		+						
17-	*Staurastrum* sp.		+								+		
	Total	**5**	**6**	**3**	**5**	**3**	**6**	**3**	**3**	**3**	**6**	**3**	**3**
	Pyrrophyceae												
18-	*Ceratium hirundinella* (Muell.) Du Jardin			+								+	
19-	*Gymnodium* sp.			+				+					
	Total	**-**	**-**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**-**
	Euglenophyceae												
20-	*Euglena* sp.	+	+			+	+			+			
	Total	**1**	**1**	**-**	**-**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**
	Rhodophyceae												
21-	*Audouinella* sp.								+				
	Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**
	Bacillariophyceae												
22-	*Achanthes offinis* Grunow	+			+	+	+		+		+		+
23-	*Amphora cymbifera* Cleve		+	+		+	+	+	+	+		+	+
24-	*A. ovalis* Kuetzing		+			+	+				+		+
25-	*A. robusta* Gregory		+	+	+								
26-	*Bacillaria paxillifer* (Muell.) Hendy				+		+	+		+		+	
27-	*Caloneis elongate* Grunow	+	+						+	+	+		+
28-	*C. limosa* (Kutz.) part		+	+		+	+	+	+			+	+

Table 2 continued .....

Table 2 continued .....

No	Name and number of Station	Al-Muthanna bridge (1)				Al-Jadiriyah (2)				Al-Za'faraniyah (3)			
	Season / Taxa	winter	Spring	summer	Autumn	winter	Spring	summer	Autumn	winter	Spring	summer	Autumn
29-	*Cocconeis placentula* Ehrenberq	+	+	+	+	+	+	+	+	+	+	+	+
30-	*C. gracillis* (Breb) Grunow	+	+		+	+				+	+	+	+
31-	*Cyclotella comta* (Ehr) Kuetzing	+			+				+	+	+		+
32-	*C. meneghiniana* Keutzing	+	+		+				+		+		+
33-	*Cymbella affinis* (Kuetz.)				+	+	+			+	+		+
34-	*C. gracilis* (Rabenhorst) Cleve	+	+	+	+	+	+	+	+	+	+	+	+
35-	*C. lancelata* (Ehr)	+		+	+		+			+			+
36-	*C. obtuse* Gregory		+		+		+	+			+		
37-	*C. ovalis* Hisle			+					+		+	+	+
38-	*C. pusila* Grunow		+	+		+							
39-	*C. tumida* (Breb) Van. Heurck	+	+		+			+	+	+			
40-	*Denticula elegens* Kuetz				+		+		+	+			+
41-	*Gyrosigma attenuatum* (Kutz.) Rabenhorst	+	+		+	+		+	+		+		
42-	*Mastogloia laminaris* (Ehr.) Grunow	+	+	+	+	+	+	+	+	+	+	+	+
43-	*M. muradi* Voiget			+			+	+	+	+			+
44-	*M. recto* Hustedt		+			+			+				
45-	*Navicula atomus* (Kutz.) Grunow	+	+	+	+	+	+				+		
46-	*N. fusca* Greg	+	+		+		+	+			+		
47-	*N. fusiform* Greg	+	+	+	+		+				+		
48-	*N. gastrum* (Ehr.) Kuetzing	+	+	+		+							+
49-	*Synedra ulna*(Nitzs) Ehrenberg	+	+	+	+	+	+	+	+	+	+	+	+
	Total	**16**	**20**	**14**	**19**	**15**	**17**	**12**	**16**	**14**	**17**	**9**	**18**
	Total all	**26**	**29**	**22**	**31**	**22**	**28**	**17**	**28**	**24**	**27**	**14**	**26**

+ Present

μgm/L in the third station during the winter and (105) μgm/L at the same station during the summer. The water of Tigris river contain on the high concentrations of the silica (Al-Fatalawi, 2007) so we observe the domains of the diatoms on the other algae in the Iraqi environment (Al-Ghafily, 1992) and that the increase of concentrations in Winter season probably goes back to the constant bottom movement and low-activity of the diatoms. The phosphate concentrations ranged from (0.17) μgm/L at the second station during the spring and (1.41) μgm/L at the same station during the summer, the increased use of phosphate-rich fertilizers and soil-washing products and drag by the river increases the concentration phosphate in the waters of the river (Al-Saadi *et al.*, 1999) (table 1).

Phytoplankton

Qualitative study

In the current study, 49 species of algae belonging to 29 genus were diagnosed, most of them returning to the Bacillariophyceae algae class, which formed a ratio of (57.14)% of the total of the diagnosed species. The following diatoms class with the domains of the species, the algae of cyanophyceae class and reached (37)% then chlorophyceae class (33)% and then the Dinophyceae the rotary algae class (4.089)%. Finally, the Euglenophyceae and the Rhodophyceae are the same as they have accounted for (2.04)% (table 3).

The present study is an attempt to diagnose and study the algae community in the Tigris River ecosystem, and the species diagnosed on the three study stations are

Table 3: Number of species and percentages of algae diagnosed in the Tigris river water by major Classes

No	Name and No. of Station / Season / Taxa	No. of Species %	Al-Muthanna bridge (1)				Al-Jadiriyah (2)				Al-Za'faraniyah (3)			
			winter	Spring	summer	Autumn	winter	Spring	summer	Autumn	winter	Spring	summer	Autumn
1-	Cynophyceae	9 18.37%	4 8.16%	2 4.08%	3 6.12%	7 14.28%	4 8.16%	4 8.16%	1 2.04%	8 16.32%	5 10.20%	4 8.16%	1 2.04%	5 10.20%
2-	Chlorophyceae	8 16.33%	5 10.20%	6 12.24%	3 6.12%	5 10.20%	3 6.12%	6 12.24%	3 6.12%	3 6.12%	3 6.12%	6 12.24%	3 6.12%	3 6.12%
3-	Bacillariophyaceae	28 57.14%	16 32.65%	20 40.81%	14 28.57%	19 38.77%	15 30.61%	17 34.69%	12 24.48%	16 32.65%	14 28.57%	17 34.69%	9 18.36%	18 36.73%
4-	Euglenophyceae	1 2.04%	1 2.04%	1 2.04%	-	-	1 2.04%	1 2.04%	-	-	1 2.04%	-	-	-
5-	Rhodophyceae	1 2.04%	-	-	-	-	-	-	-	1 2.04%	-	-	-	-
6-	Dinophyceae	2 4.08%	-	-	2 4.08%	-	-	-	1 2.04%	-	-	-	-	1 2.04%
		100 100%	26 63.06%	29 59.18%	22 44.89%	31 63.26%	22 44.89%	28 57.14%	17 34.69%	28 57.14%	23 46.93%	27 55.10%	13 26.53%	26 53.06%

organized according to the studied classes (table 2). It was noted that the growth of algae in the spring and autumn season was more than the other two seasons, as the study indicated that chlorophyceae was appear in the spring while cyanophyceae were more present in the autumn.

The algae common to the water of the three stations amounted to (7) species: (1) species of cyanophyceae and (2) species of chlorophyceae and (4) species of diatoms these species are:

Oscillatoria princepes, *Pediostrum boryanum*, *Pediastrum simplex*, *Cymbella gracilis*, *Mastogloia laminaris*, *Cocconeis placentula*, *Synedre ulna.*

Of the genus that are registered more than one species are: from cyanophyceae genus *Oscillatoria* and from chlorophyceae the genus *Pediastrum* and from diatoms the genus *Amphora*, *Caloneis*, *Cocconeis*, *Cyclotella*, *Cymbella*, *Mastogloia*, *Navicula*.

Among the species that have been present in other stations are: *Oscillatoria tenuis* and *Audouinella* sp. At the second station, this may be due to the quality of the physical and chemical characteristics that have been reflected in the biological diversity of the studied station.

The results of the analysis of the list of algae diagnosed in this study show that the first station recorded the highest number of (31) species in the autumn and this the increase is due to the increase in cyanophyceae and diatoms algae, which is reflected in the total number of plant numbers followed by the second stations and the third where reached to (28) in the spring and autumn in the second station and (27) in the spring in the third station. The spring and autumn increment has been recorded at all stations and for the above seasons and is consistent with most studies on the waters of the Tigris River (Al-Kubaisi *et al.*, 2001; Al-Maqdmi, 2016).

The species of diatoms, chlorophyceae and cyanophyceae algae formed (45) species of current study and a presence rate of (91.82)%, featuring Iraqi developing environment with the domains of the diatoms on other algal classes this was confirmed by previous studies, whether in river water, lakes and marsh (Al-Ghafily, 1992). The current study found the domains of the diatoms (table 2) by the number of species and genus in all stations and during the seasons of the year that is consistent with the current study (Al-Dulaimi, 2013).

References

Abdin, G.; K.A. Al-Kaisi and F. Naib (1957). Some observation on the algae flora in and round Baghdad, **2**: 31-43.

Al-Asady, S.M.A.-A. (2015). Environmental study of the algae community and some environmental pollutants in Al-Husseiniya - Holy Karbala. Iraq. PhD. thesis. College of Education for Pure Sciences. University of Karbala: 232 pp.

Al-Dulaimi, A.I. H. (2013). An environmental and diagnostic study of algae in the Tigris River for the city of Al-Dhuluiya and its suburbs within the governorate of Salah Al-Din. Master Thesis, Faculty of Science, University of Tikrit: 120 pp.

Al-Fatalawi, Y.F.K. (2007). Evaluating the efficiency of the liquefaction projects in Baghdad. PhD / Faculty of Science, University of Baghdad.

Al-Ghafily, A.A.K. (1992). A study on algae in Al-Razazah Lake. MSc. Thesis. College of Science / University of Baghdad.

Al-Janabi, Z.Z.F. (2011). Applications of water quality indicators in the Tigris River within the city of Baghdad - Iraq. MSc. Thesis, College of Science for women/University of Baghdad.

Al-Kaisi, K.A. (1976). Contribution to the algal flora of the rice fields of southeastern. *Iraq Nova Hedwigia*, **27**: 813-827.

Al-Khalidi, N.M.S. (2004). The effect of the different levels of the Tigris River in the change of the living ecosystem in the river between the bridge Al-Muthanna and the mouth of the River Diyala. MSc Thesis, Department of Geography, College of Arts, University of Baghdad: 228 pp.

Al-Kubaisi, A.-R., H.A. Al-Saadi and A. Murtada (2001). An environmental study of phytoplankton in the Tigris River before and after passage in Baghdad. Iraq. *J. Envir.. Res. and Sustain. Develop*., **4(2)**: 52-78.

Al-Lami, A.A., T.L. Kasim and A.A. Al-Dulymei (1999). A limnological study on Tigris river. Iraq. *Sci. J. Iraq Atomic Energy Commission*, **1**: 83-98 pp.

Al-Maqdmi, B.A.-A. H. (2016(). Study of the community of algae diatome in the Tigris River between Baghdad and Al-Dijail. PhD thesis, College of Education for Pure Sciences, University of Baghdad: 243 pp.

Al-Saadi, H.A., A.A.-Z., Al-Lami and T.I. Kassem (1999). Study of the environmental characteristics of the Upper Tigris and Euphrates rivers and their relation to the development of fish wealth in Iraq. *J. Envir. Res. Sustain. Develop*., **2(2)**: 20-31.

Al-Shindah, B.T.I. (2008). Study of some physical and chemical properties of the Tigris River within the city of Tikrit. MSc. Thesis, College of Science, University of Tikrit: 112 pp.

Al-Tamimi, A.A.M. (2006). Algae use biological evidence to contaminate the lower part of the Diyala River with organic matter. PhD thesis, College of Education - Ibn Al-Haitham, University of Baghdad: 208 pp.

APHA. (1976). American public health association standard method for the examination of water and waste water, 14th. ed.

APHA. (2005). American public health association standard method for the examination of water and waste water, 21st.ed.

Bold, H.C. and M.J. Wyne (1985). Introduction to the algae, structure and reproduction. 2nd. Edi. Prentice-Hall. Inc. Englewood Cliffs, 720 pp.

Desikachary, T.V. (1972). Taxonomy and biology of cyanophyceae. Univ. of Madras: 196 pp.

Germain, H. (1981). Flora des diatomess. Diatomphyceae eau douces et saumatres du Massi of Armoricion et des contrese voisines d Europe occidental. Societe Nouvelle des edition Bubee., Paris: 444 pp.

Gilpin, L.C., K. Davidson and E. Roberts (2004). The influence of changes in nitrogen growth dynamics. *J. Sea. Res*., **51**: 21-35.

Hadi, R.A.M., A.A. Al-Saboonchi and A.K.Y. Haroon (1984). Diatoms of the shatt Al-Arab River, Iraq. *Nova Hedwigia*, **39**: 517-557.

Hoyos, C.D. and J.C. Vega (2000). Phytoplankton structure and dynamics in Lake Sanabri and Valparaiso reservoir (NM spain). *Hydrobiologia*, **424**: 25-37.

Lind, O.T. (1979). Hand book of common methods in limnology C. V. Mosby. St., Louis: 199 pp.

Maoulood, B.K., M.N. Al-Azzawi and H.A. Saadalla (1994). An ecological study on the Tigris river pre and after crossing Baghdad. J. *College Educ. women. University of Baghdad*., **5(1)**: 43-50.

Maulood, B.K., H.A. Saadi, H.A.S. Adhami (1990). Environment and practical pollution. Higher Education Press. Books and documents. Baghdad, Iraq: 252 pp.

Munir, M., R. Qureshi, M. Arshad, A. Chaudhry and M.K. Laghari (2012). Taxonomy study of Bacillariohyta from Kallar Kahar lake Chakwal. Punjab. *Pakistan. Pak. J. Bot*., **44(5)**: 1805-1814 pp.

Muthani, A-S and I.M. Salman (2007). Practical environment Field and laboratory studies. First Edition. Publications of the University of Sabha. Libya: 407 pp.

Nurul-Islam, A.K.M., A.N. Khalaf, M.S. Mohammed and A.R. Al-Jafery (1982). Ecological study on the planktonic algae of Rashidiyah reservoir. *Iraq. J. Sci*., **23(3)**: 443-458.

Parsons, T. R., Y. Maite and C. M. Lalli (1984). A manual of chemical and biological methods for sea water analysis. Pergaman press. Oxford.

Patrick, R. and C.W. Reimer (1975). The diatoms of the United States. Vol.2., Part 1: 213pp.

Prescot, G.W. (1982). Algae of the western great lake area. William C. Brown Co., Publisher. Dubuque. Iowa, pp: 977.

Prescott, G.W. (1973). Algae of the western great lake area. William C. Brown Co., Publisher. Dubuque, Iowa: 348 pp.

Prescott, G.W. (1979). How to know the fresh water algae. 3rd. William C. Brown Co., Publishers. Dubuque. Lowa: 348 pp.

Reiol, G.K. (1961). Ecology of in land water and estuaries. Rhenal Publ. Corp. N. Y. Chapman and Hall Ltd. London; 375 pp.

Saadallah, H.A.A. (1988). Environmental study on the effect of the façade of Saqlawiyah on the Tigris River in the city of Baghdad. MSc. Thesis - University of Baghdad.

Sahaf, M. (1976). Iraq's Water Resources and Pollution Maintenance. Republic of Iraq, Ministry of Information: 307 pp.