Plant Archives Vol. 19 No. 2, 2019 pp. 4445-4452 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EPIPELIC ALGAE AND THEIR RELATION TO THE NATURE AND COMPOSITION OF THE BOTTOM IN A SECTION OF THE GHARAF RIVER IN SOUTHERN IRAQ

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Abstract

The current study conducted in the summer to the study the effect of some environmental factors and the nature of the chemical composition of soil texture that the nature of chemical composition and soil texture has an effect on the diversity of epipelic algae, as 96 species were diagnosed that belongs to (37) genus. The site where the highest number of diagnosed algae species (44 species) was recorded compared to other sites with a high percentage of calcium and calcium carbonate and the soil texture at the site above was characterized by the highest percentage of sand (23.81%). The lowest percentage of alluvial soil (27.48%), while the lowest number of diagnosed species (18 species) was characterized by a high percentage of heavy metals (cadmium, iron, chromium, lead and zinc) and a decrease in the value of the silica, while the soil texture of the same site was characterized by the highest percentage for clay (51.743%).

Key words: Epipelic algae, pollution, soil texture and environmental factors.

Introduction

The Garaf river is one of the main branches of the Tigris river, which branches from it at the Kut dam, thus deriving its characteristics from the Tigris river. The Garaf basin is inhabited by more than one million people using about 432,000 cm^3/year of water and it is difficult to determine the annual discharge rate of water due to large annual fluctuations, it suffers from natural and human problems affecting its ecosystem, such as mud accumulation, growth of plants such as *Typha* sp., *Phragmites australis*, *Ceratophyllum demersum*, *Potamogeton* sp. and *Vallisineria spiralis*), frequent water losses and water level fluctuations during one year (MOAI, 1991, Zahraddeen and Murja, 2018).

The study area is characterized by seasonal soils, which are mainly formed from sediments carried by the Tigris river and its branches from the upper basin and is characterized by a alluvial and mixture texture and its salinity varies from a few to medium salinity by (4.58) dsm/m in the areas of the River levees and to high and severe salinity at (11.10) dsm/m in low-lying basin areas (Alabdelllah, 2006, Ewaid, 2016).

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The edges of the light-exposed rivers (fresh water) are characterized by the growth of different aggregates of algae, most of which are due to blue-green algae and different types of algae, eukaryotes and may accumulate on or inside the bottom deposits (Hassan *et al*., 2007, Lysakova Poulikova, 2007) for these algae in a role mainly in the recycle of nutrients through the water column and sediments as well as being primary products, as well as a food source for benthic invertebrates and small fish and also works to draw and accumulate toxic and harmful substances from the aquatic environment and help purify water from foreign substances, as are sensitive indicators for environmental conditions in various water habitats (Angermeier and Alsalman, 2005, Rosenberger, 2005, Sigee, 2005, Al-Mughdemy, 2018).

Benthic algae are affected by a number of factors including the intensity of the lighting, its length of period, temperature, nutrient levels, grazing, sediment nature and rapid flow (LiLi *et al*., 2010). Some epipelic algae attached to clay are home to and shelter many aquatic organisms such as Protista and they may compete it with it in symbiotic relation (Tundisi and Mastsumura -Tundisi, 2003). The nature of the bottom plays a major role in the

diversity of epipelic algae attached to it (Aktan *et al*., 2014). Therefore, due to the lack of studies in the Iraqi environment and the study area especially in this area, so the current study tries to highlight the effect of the nature and composition of sediments on the diversity of epipelic algae attached to clay in five sites on the Garaf River in Dhi Qar province in southern Iraq.

Materials and Methods

The current study was carried out during the summer period of the months (June, July, August) of 2018 and the results of the physical and chemical properties tests for the three months were considered as repeaters to determine the final values of the properties studied and each according to the appropriate modus operandi. Eaton and Moss (1966) method used the method of collecting and isolating algae from clay.

The conductivity meter was used to measure each of the total dissolved solid (TDS) and the results were expressed in mg/L, electrical conductivity (E.C) their results were expressed in micro Siemens/cm and the value of power of hydrogen measured by using a pH-meter. While it was estimated magnesium concentration using atomic absorption spectrophotometer and used the same device to estimate the total concentrations of some heavy elements, namely iron, cadmium, chromium, lead and zinc in clay samples after the completion of the process of digestion. The calcium was estimated by using flame Spectrophotometer and the titration was used to estimate H_2CO_3, adopted the method described in APHA (2005) for estimating nitrates NO_3, silica, sulfates and PO_4, while multi direct photometer was used with kits to estimate total organic carbon.

Five sites were selected to collect study models from the sediments of the River Garaf from the Al-Kalaa district to Al-Shatra district within Dhi Qar province and the area studied has reached about 59 km and these sites were selected on the basis of the diversity of human activities and not on the basis of distances as the river passes through residential areas on both edges in addition to the presence of farms, fixed and floating fish ponds, sewage, cross-barriers and some dams that have direct effects on the river. These additives affect algae and the organisms within the water as well as the physical and chemical properties of it. To see the different effects of these additions on the presence of algae, these sites were selected and identified using the geographic information system (GIS) program as shown in fig. 1, where the symbols ST1, ST2, ST3, ST4 and ST5 respectively. The first location is located in Al-Kalla district - before entering the city-and is characterized by the presence of farms on both sides, the second site in Al-Rifai district-before entering the city-where there are fish basins which are about (18 km) south of the first site, the third site is located just south of Al-Nasr district, which was characterized by the presence of pipes for sanitation and is far away about (29 km) from the previous site, the fourth site in Al-Badaa area belonging to Al-Shatra district about (8 km) which is represented by the presence of the accidental barrier that was created to collect the flower of the Nile, the fifth site is the dam of Al-Badaa in the area of Al-Badaa also, which is away from the fourth site about (4 km) which is characterized by with the presence of Al-Badaa dam, which is a dam that was built to regulate the flow of water.

Results and Discussion

Physical and chemical factors

The importance of temperature study comes when conducting various environmental studies and is given priority among the rest of the physical and chemical factors

Table 1: The mean ± standard error and rate for the characteristics studied for the bottom soil by different sites.

Site / Factor	ST.1	ST.2	ST.3	ST.4	ST.5	Rate
Temp	2±25b	2±25b	2±29a	3±22a	2±20c	26.2
Mg mg/kg	1.52±49.83e	2±50.3d	2±70.7a	1.52±60.33b	2±57.3c	57.692
Ca mg/kg	1.52±97.41b	2±107.41a	2±87.40d	2±70.17e	2±90.15c	90.508
$Caco_3$ mg/kg	2±501b	2±6032a	1.52±598.3a	2±507b	2±509b	543.66
NO_3 mg/kg	0.02±0.77a	0.02±0.54b	0.02±0.33b	0.02±0.81a	0.02±0.9a	2.63
PO_4 mg/kg	0.015±0.283b	0.02±0.17d	0.02±0.23c	0.02±0.22c	0.02±0.47a	0.2747
Silica mg/kg	0.01±7.98b	0.2±9.4c	0.2±11.3e	0.02±9.88d	0.02±1.45a	8.002
So_4 mg/kg	2±127.5b	1.52±109.86d	2±132.1a	2±117.5c	2±101.1e	117.613
Toc mg/kg	0.01±2.68d	0.02±2.77c	0.02±2.54d	0.2±3.6b	0.1±4.1a	3.13
pH	0.01±7.91c	0.01±8.01a	0.02±7.93c	0.01±8b	0.015±7.98b	7.96
Org.Mat mg/kg	0.15±4.13e	0.2±6.9b	0.2±7.4a	0.02±4.47d	0.01±5.02c	5.58
T.D.S. mg/kg	2±1017c	1±1011d	1±1001e	1.52±1275.3b	2±1435a	1147.86
E.C. µS/cm	2±1535c	2±1424d	2±1402e	1±1698b	2±1753a	1562.4

Table 2: The means ±standard error and kg/ig rate for heavy elements.

Element	ST.1	ST.2	ST.3	ST.4	ST.5	Rates
Cd	0.001± 0.041a	0.002± 0.038a	0.001± 0.021b	0.002± 0.048a	0.02± 0.050a	0.0396
Fe	2± 470.3c	2± 403.1e	2± 422.3d	2± 593.5b	2± 717.5a	521.34
Cr	0.02± 73.94c	1± 68.1d	0.4107± 58.57e	0.2± 79.5b	2± 88.34a	1822.82
Pb	0.02± 4.03b	0.02± 3.9d	0.02± 2.57e	0.02± 3.74c	0.02± 5.92a	3.87
Ni	0.1± 68.1d	0.2± 73.4c	0.2± 53.4e	0.2± 91.7a	0.2± 88.4b	75
Zu	0.2± 28.4d	0.2± 33.4b	0.02± 21.8e	0.02± 29.15c	0.2± 34.5a	29.45

Table 3: Shows the percentages of soil texture separates in the sites studied.

Soil structure	ST.1	ST.2	ST.3	ST.4	ST.5	Total
Sand	20.92	23.81	19.447	27.98	20.152	22.461
Alluvial	31.42	27.48	29.38	30.292	28.105	29.335
Clay	47.66	48.71	51.173	41.728	51.743	48.202

because it has multiple effects on biological factors directly or indirectly. The results of the current study showed differences between the sites studied in temperature rates as the highest rate (32°) in the fourth site and the lowest rate (20°) in the fifth site (Table 1), the variation in temperature between the sites is due to the different time of taking the sample, as the temperature is low in the morning and gradually rising in the middle of the day

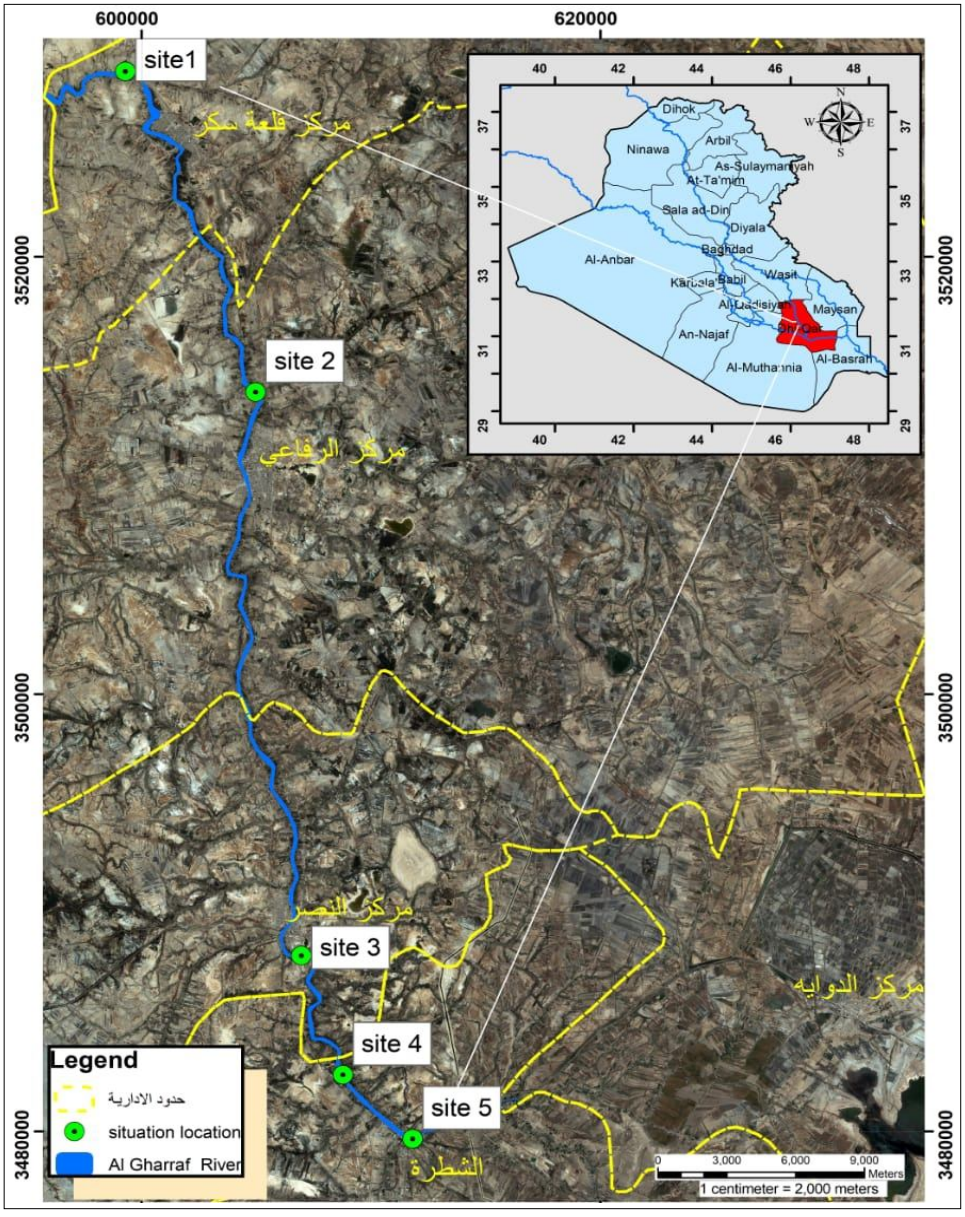

Fig. 1: A map showing the study area and the selected sites on the Garaf River (GIS).

Table 4: The number of genus and species of benthic algae species (Epipelic algae) attached to the mud diagnosed at the five sites studied in the Garaf River during the study period.

Taxa		G.	SP.	G.	SP.	G.	SP.	G.	SP.	G.	SP.
Cyanophyta		5	7	3	6	3	5	2	2	3	4
Chlorophyta		2	2	2	2	0	0	2	2	1	1
Euglenophyta		0	0	1	1	0	0	0	0	0	0
Bacillariophyceae	Centrales	1	1	1	1	2	2	-	-	-	-
	Pennales	11	29	15	34	11	18	9	13	8	17
Total		19	39	22	44	16	25	13	21	12	18

**G: genus. **SP:Species.*

(Hassan *et al.*, 2007). Large climate changes also have a clear effectiveness on implies their year-to-year fluctuations (Olden, 2014, Jaeger and Olli, 2017).

pH values at study sites were narrow and did not vary significantly, ranging from (8.1-7.93) to buffer capacity, where it resists changes in hydrogen (Galic *et al*., 2018). The values of total phosphorus ranged between the highest value (0.283) mg/L in the first location and the lowest value (0.17) mg/L in the second location and may be due to the high value of phosphorus because the site is located within an area with agricultural activities and also poses many household wastes, as the concentration of phosphorus was differed in river water according to the nature of the surrounding land, population density, quality of agriculture and rock layers, as well as the amount of household waste on river and this conclusion is consistent with the opinions of researchers Díaz *et al*., 2019 and Guzha *et al*., 2019.

The highest value of silica and sulfates in the second site was 11.3 and 1321 respectively, while the lowest value was 1.45 and 1101 in the same order in the fifth site and the high values of sulfates can be due to the high sulphur dioxide content in the atmosphere resulting from the combustion of fuel and concentrated fuel of vehicles that may reach the hydrosphere when it falls in dry minutes in addition to the erosion of the rocks and the nature of the soil that passes through the riverbed (Unu-Inweh, 2013, Dreschsler and Johts, 2017, Ewaid *et al*., 2017).

The highest value of E.C and T.D.S. was measured 173, 1435 mg/L respectively at the fifth site and the lowest value is 1402 and 1001 respectively in the second site, the rise in the values of electrical conductivity and total dissolved salts at the fifth site may be due to rocks in the river environment in general and the nature of soil adjacent to the study area (Varis, 2014, Reddy *et al*., 2019). The highest value of calcium and calcium carbonate was 10741, 603 respectively in the second site and may be due to the increase of algae at that site during the study which led to the use of a lot of CO_2 is in the process of photosynthesis, resulting in high pH values and thus the deposition of calcium carbonate (Defabricius *et al*., 2003, McInthre, 2019) while the lowest value of calcium carbonate was 501 in the first site and calcium was the lowest value was 7017 in the fourth site.

The highest value of the organic material was in the third site was 7.4 while the lowest percentage in the first site was 4.13 in addition to the presence of locational variations at the probability level ($P \leq 0.05$) between the study sites, this may be due to the variation in the density of vegetation, especially the reed plant, which may lead to increased accumulation of plant remains and other organic matter stuck in water and not drifting due to low water level and slow flow (Sanchez and Carrillo, 2001, Kazmierczak *et al*., 2015, Alsalman and Al-Maghdemy, 2018). This is distinguishes the site above as containing rich sewage organic materials.

While the highest value of organic carbon 4.1 in the fifth site and the lowest value is 2.68 in the first site, the increased release of organic matter leads to increased organic carbon or as a result of the presence of submersible plant residues as well as the presence of plants for most months of the year, which helps to keep the sediment for permanent stock of organic matter (Galic *et al*., 2018, Neeson *et al*., 2019). The lowest values were recorded at the first site where it reached (2.68) and may be due to the geology of the river soil (Reddy *et al*., 2019) or as a result of the effect of the consumption of benthic animals of carbon produced (Moriarty, 1985). The towed consumes 40 percent of the world's population of carbon produced from bacteria on one summer day.

With regard to heavy metals (Table 2), the highest values for cadmium, iron, chromium, lead and zinc were recorded 0.050, 7175, 88.34, 5.92 and 34.5 respectively in the fifth site, which may be due to the high pollution at this site resulting from the reservation of waste dumped in the river, human activities such as dead animals and various plants that are washed away by the river and remain stuck in dams and cross-barriers in the river, which are frequently found in the fourth and fifth site. This was noted by the researchers Ali and Abdel-Satar (2005), Galic *et al*., (2017) and Srinivasan *et al.,* (2017) that high temperatures in spring and summer help to increase the release of heavy metals from sediment in areas with organic pollution.

The results of the current study also showed that the nature of the soil tissue was a sand-alluvial-clay in the

Table 5: Species of algae diagnosed at the sites during the study period (+ species present, - species absent).

Taxa	ST-1	ST-2	ST-3	ST-4	ST-5
Cyanophyta					
Anabaena.sp	+	-	+	-	-
Aphanotheca nidulans var endophytica	+	+	+	+	-
A. nidularis P. Richter	+	-	-	-	-
A.microspora	+	+	-	-	-
Merismopedia. minima Heck	+	-	-	-	-
Nostoc sp	-	-	-	-	+
Oscillatoria.anguna	-	+	+	-	-
O. prolifica (Grev.) Gomont	+	-	+	-	-
O.nigra	-	+	-	-	-
O.princps	-	+	+	-	+
O. minma	-	-	-	-	+
Phormidum sp	+	+	-	+	+
Chlorophyta					
Closteriopsis longissima (Lem.)Lemm	+	-	-	-	+
Chlamydomonas. sp	-	+	-	+	-
Chlorella. sp	-	+	-	-	-
Spirogyra .crassa Ktz	+	-	-	-	-
Scenedesmus bijuga (Turp) Lagher	-	-	-	+	-
Euglenophyta					
Euglena.graciles	-	+	-	-	-
Bacillariophyceae					
Centrales					
Thalassiosira weissflogii Grunow	-	+	+	-	-
Melosira ambigua Muller	+	-	-	-	-
M.reosena rabenhorst	-	-	+	-	-
Pennales					
Achnanthes affinis	+	+	-	-	+
A. minutissima Kuetzing	-	+	+	-	+
A. microcephale (Ktz.) Grunow	+	-	+	-	-
Amphora normannii Rab	-	-	+	-	-
Amphipleura pellucida (Ktz.) Kuetzing	+	-	-	-	-
Cocconeis.placentula	-	-	-	-	+
Coscinodisus lacustris Grunow	-	-	-	+	-
Cymbella affinis (Kuezing	+	+	-	+	-
C.ventrcosa	-	+	-	-	-
C. microcephale Grunow	+	-	-	+	-
C.amphicephala	-	+	-	-	-
Caloneis amphisbaena	-	+	-	-	-
C. helvetica Kuetzing	-	-	+	-	-
C. prmagna	-	+	-	-	-
Cymatoplenra solea (Breb.) W.Smith	+	-	-	-	-
Cyclotella glomerata Bachmann	-	+	-	-	-
Denticula tenius var tenuis Kutz.	-	-	-	+	-
Diatoma hiemala var. mesodon (Ehr.) Grun	-	-	+	+	-
Eunotia. formica Ehrenberg	+	-	+	-	+
E. pectinalis var. undulata (Ralfs) Rabenhorst	+	-	-	-	-
E . lunaris	-	+	-	-	-
E. monodon Ehrenberg	-	+	+	-	-

Table 5 Continue...

five sites with a variation in the proportions of the three components according to the nature of the site (Table 3) and the distinction of the second site, which recorded the highest number in the variety of species for the genus (22 species) with the highest percentage of sand (23.8) (1). The lowest percentage of alluvial soil (27.48), while the highest percentage of clay was (51.743) in the fifth site, which recorded the lowest number in the appearance of genus (17 species) of the species of algae diagnosed, which shows that the different nature of soil texture between the sites studied has an effect on the distribution and diversity of algae species Round (1984), Hassan *et al*., (2007), Chen *et al*., (2016) and Singer *et al.,* (2016) stated that seasonal changes and the composition and production of the benthic algae community are influenced by the chemical composition of sediments and their contents of nutrients, organics and various pollution factors.

The qualitative study of algae

Epipelic algae play an important role in the aquatic environment as they are the primary product of energy and dissolved oxygen by their role in photosynthesis as well as sediment stabilization (Alsalman and Al-Maghdemy, 2018, Neeson *et al*., 2019). The number of species diagnosed in all sites (96) species belong to (37) genus (Table 3) and the local variation in the qualitative composition between the sites of epipelic algae attached to clay, the second site occupied the largest number in the qualitative composition between all sites, which was 44 species and 22 genus and then the first site and the number of species (39) and (19) genus, the lowest numbers, which is (18) species and (12) genus in the fifth position and show that bacillariophyceae class was totally dominance in percentages over other algae varieties diagnosed in all five sites

Table 5 Continue...

Fragilaria Intermedia	-	+	+	-	-
F. brevistriata Grunow	+	-	+	+	-
Fragillaria sp	+	-	-	-	-
F. capucina Desmazieres	+	-	+	-	-
F. virescens Ralfs	-	-	-	+	-
Gyrosigma .sp	-	+	-	-	-
G. strigilis (W.Smith) Griff et. Henfr.	+	-	-	-	-
G. attenuatum (Ktz.) Rabenhorst.	+	+	-	-	-
Gomphonema constrictum	-	+	-	-	-
G. parvulum (Ktz.) Kuetzing	-	-	-	+	-
Mastogloia smithii Thw. Ex W.Sm	-	+	-	-	-
Navicula graciles	+	+	-	-	-
N.trivialis	-	-	-	+	-
N. cryptocephala	-	-	-	+	-
N. distans (W.Smith	-	+		+	-
N.gregaria	-	+	+	-	-
N. lanceolata (Ag.) Kuetzing	+	-	-	-	-
N. radiosa var. tenella (Breb.) Grunow	+	-	-	+	-
N. hantzschiana Rabenhorst	+	-	-	-	-
N.salinarum	-	-	-	-	+
N. contenta var. bicips Arn	-	-	+	-	-
N .halophila	-	+	-	-	-
N. radiosa var. tenella (Breb.) Grunow	+	-	-	-	-
Nitzshia.obtusa	+	+	-	-	-
N. clausii Hantzsch	+	-	-	-	-
N.fasculata	+	+	-	-	-
N.palea	+	+	-	-	+
N.sigmoidea	-	+	-	+	+
N.hantazchiana	-	+	-	-	+
N.paleacea	-	+	-	+	-
N.graciles	-	+	-	-	-
N.paxillfer	-	+	-	-	-
N.umbonata	-	+	-	-	-
N. linearis	-	-	-	+	-
N.acuta	+	-	-	-	-
N.hungarica	+	-	-	-	+
N.sigma	-	-	-	-	+
N. romana Grunow	+		+	-	-
N.tryblionella var.debilis	-	+	-	-	-
N. intermedia Hantzsch ex Cleve et Grun	-	-	+	-	-
N. pusilla W.Smith		-	-	+	-
N. commutata Grunow	+	-	-	-	-
Peronia fabula Ross	-	-	+	-	—
Pinnularia leptosome	-	+	-	-	-
Pinnularia.sp	-	-	-	-	+
P.biceps	-	-	-	-	+
Plearosigma angulatum (Quek.) W.Smith	-	+	+	-	-
Synedra. Ulna	+	-	-	-	+
S.vaucheriae Kutz	-	+	-	-	-
S.inuscula Grun	-	+	-	-	-
S. parasitica (W.Smith) Hustedt	-	-	-	+	-
Surirella angusta Ktuezing	-	-	+	-	-
Surirlla. ovata Ktz	+	+	+	-	-

studied and was (81.25%) then came the blue-green algae, by 12.5%, then green algae by (5.20%). Only one species was found in the second site, accounting for 1.04 percent of the population of the total diagnosed algae.

The high number of species diagnosed in the second location (Table 5) may be due to the fact that this site was affected by high concentrations of nutrients compared to other sites, as well as additions from nearby agricultural land on both sides of the river (Al-Kenany, 2011). Solar is more compared to other locations, as it is between (Farhud, 2012) that the temperature rise resulting from the power electrical plant, suitable for the natural growth and increase of benthic algae as well as the availability of nutrients from the degradation of organic matter by water-temperature-analyzed organisms (Diaz *et al*., 2019).

The decrease in the number of diagnosed species for the fifth site may be due to the high percentage of heavy elements (cadmium, zinc, copper, iron and chromium) as these elements recorded the highest values of the site above, as the researchers Medley and Clements (1998) explained that most types of diatoms are sensitive to the high concentration of heavy metals when they studied the response of the community of diatoms to metals in the streams, they found that the samples of the diatoms taken from the sources of the streams are rich in species and prevail in small species such as *Achnanthes minutissima* and *Fragilaria vaucheriae* and at the estuary there is less abundance result of the increased concentration of some heavy metals, as they presented the samples of the community of diatoms to a mixture of metals, zinc Zn, copper Cu, cadmium Cd and this treatment caused the disappearance of some very sensitive species of contamination with these metals such as *Diatoma vulgare* and *Melosira varians*, which were

located within the community of diatoms in the streams.

These two species are biological indicator of the increased concentration of these minerals in the water streams, as confirmed by the current results as the *D. vulgare* and *M. varians* were not diagnosed in the fifth site, in addition to the decrease in the value of silica in the same site. Shehata and Bader (2010) were stated that dissolved silica are an important nutritional component of diatoms as it is involved in the formation of the casings of the walls of its distinct cells (diatoms envelopes).

Conclusions

From the results obtained from the study it can be concluded that soil texture has an effect on the diversity of epipelic algae, as well as the variation of the ratios and type of heavy metal had a clear effect on the diversity of algae and the degree of tolerance of different types of pollution levels with this element, especially the cadmium and iron, as for the different human activities in the study area, had an impact on the physiochemical properties of river water, which indirectly affected the life of the algae community targeted by the study, as well as the study indicated the great disparity in climate variability, decline, sharp rise in the level of the water column, speed and slow flow of water and its effect on the quantity and quality of algae at the study sites.

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