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Taxonomical and Ecological Study of (Non-Diatoms) Agricultural Soil algae In Shatt Al-Arab District in Basra Governorate

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Abstract:

Classification of non-diatomic algae in the agricultural soils of Shatt Al-Arab district were studied for an entire year starting from November 2020 until September2021.Diifferent environmental parameters (Temperature of soil and air, salinity, pH and some nutrients) were studied. The current study identified 72 taxonomic units belonging to two divisions, the blue-green algae and the green algae, the appearance of algal species was highest in the spring months and the lowest in July. The study identified five new species of blue-green algae represented by *Gloeocapsopsis chroococcaides*, *Lyngbya regalis*, *Oscillatoria salina* , *Phormidium breve*, *Phormidium tinctorium*. The results also showed the dominance of blue–green algae at the expense of green algae, and the genus *Oscillatoria* recorded dominace over the rest of the genera, and the results of the statistical analysis showed that temperature, salinity and conductivity were inversely associated with the number of algae species, while the nutrients represented by nitrogen, phosphorus, and available potassium were directly associated with the number of algal species.

Key word: Algae, Identification, Chemical and Physical factors

Introduction:

Soil is the source of life, place for plant stability , and it is home to plant and animal life, including algae (Hu *et al*.,2003) in which some species spread abundantly in moist soils(Bot & Benites,2005). The soil is considered major medium for organic and non-organic materials, and due to the importance of the soil, it was necessary to know the neighborhoods in which it resides, including algae, which are simple living organisms that differ in their vegetative forms ,some of them take the shape of regular and irregular aggregations motile or non-motile, while others are unicellular which in turn are motile or non-motile, it is also present in the form of algal filaments, branched or un branched forme,as well as its Parenchymatic and Siphonic (Lee,2008). Soil algae are located few centimeters below its surface, as they have an important role in improving soil properties, since their filamentous increases its porosity(Song *et al*.,2005),it participates in stabilizing its surface and protects it from erosion resulting from rain and wind(Whitton,2000),by forming acohesive surface layer above the soil surface and increasing its surface area through its secretion of some gelatinous substances that are important in increasing its ability to retain water(Roger&Reynaud,1982).It also plays an important role in adding group of important compounds to the soil ,including growth regulators ,vitamins ,amino acids ,sugars and other metabolic compounds that have direct or indirect

effect on plant (Prasanna *et al*.,2008).They are also among the living products that have been used as bio fertilizers because of their ability to fix atmospheric nitrogen as result to contain a Nitrogenase enzyme (Ladha&Reddy,2003),as well as its ability to improve soil salinity and increase the productivity of field crops (Charma *et al*.,1989). Because most of the studies about algae in Iraq represented of studying the aquatic environment, the Iraqi soils has received only a few studies, so this study came to identify the specific composition of non- diatom algae in the soils of some sites in Basra Governorate ,as well as to identify some new species that were not identified from before and knowing the physical and chemical properties of the soils indicating their effect on the studied algae.

Materials and methods:

Study sites

The study area included different areas of the Shatt Al-Arab district, which is one of the districts of Basra Governorate, and it is one of the cities in Iraq, which is located in the south east as it extends geographically between two circles of latitude3116.45 and 29 6.21north and two arcs longitude48 37.31 6 and46 43.334eastward.The climate of Basra Governorate is characterized by high temperature ,lack of rain, and the length of the hot summer season, which is characterized by drought and high evaporation ,while the winter season is characterized by moderate temperatures and little rain. As for the study site, which is the Shatt Al-Arab district it is located on the eastern bank of the Shatt Al-Arab river , and it extends from the Qurna district to the Iraqi-Iranian borders, and there are many streams and rivers in it. it is characterized by the cultivation of tomatoes,

jute and some vegetables, as well as palm trees.

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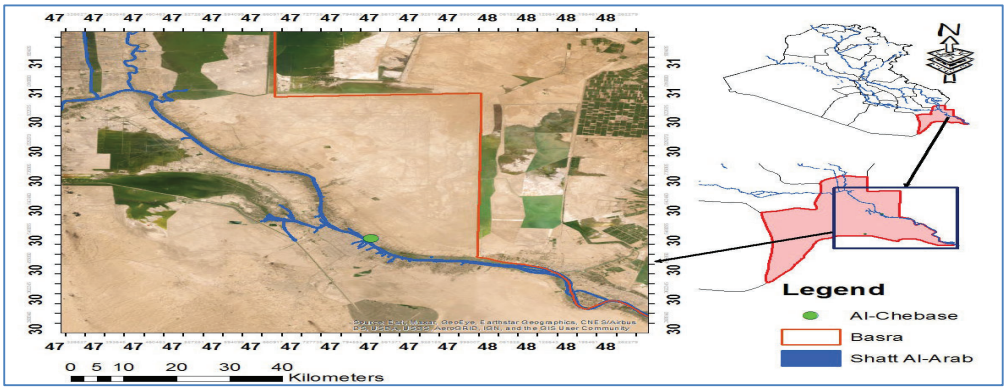

Figure (1): Satellite map of Basra Governorate showing the collection location of algae and soil samples

Sample collection

Soil samples containing algae were collected from different locations in Shatt Al-Arab district ,four samples for each area. As the samples were collected every two months, soil algae were isolated from the method the described by (Moss, 1966).Algae samples were collected from the surface layer of moist soil in three cm deep using a sharp shovel .The clay samples containing algae were placed in plastic bags . The information about the samples was noted (the depth of samples were taken, the date and place of collecting the samples).A small volume of distilled water was added to each sample , than it was closed and left without moving until returning to the laboratory. Several petri dishes were

taken and 40 gm of clay was placed in each dish and spread it inside the dish , after that papers placed to clean the lenses on the surface of the clay in the dishes from which the algae was intended to be isolated .The dishes were covered so that the algae would stick to it and then it was exposed to very dim light during the night and left until the next morning . After that ,the lens cleaning papers and the algae that stuck to them were removed and placed in glass tubes with a capacity of 25ml after cutting them in to small pieces,10ml of distilled water was added to it with(4-5)drops of Lugle solution as a preservative, then it was shaken well, after that the algae were identified by making glass slides, as they were examined under light microscopic under40x magnification examined under alight microscope under 40x magnification and using the following classification sources:

Desikachary(1959);Prescott(1973);Taylor&Annelise (2006);John & Robert(2015)
.In addition to collecting soil samples at a depth of 30 cm , they were placed in plastic bags and their information was recorded (the place and date of sampling and the depth from which the soil was taken). After that, it was delivered to the laboratory ,and it was spread in aluminum pots for the purpose of during it after that it was ground using steel mortar, then it was sifted with a sieve with hole diameter of 2 mm ,and it was mixed and placed in tightly closed plastic bags (Mullins & Heckendom, 2005), after which its physical and chemical properties were studied.The different of chemical and physical factors (temperature of air and soil,pH,salinity and N,P,K) were studied in this study.

Results:

The study identified (72)taxonomic units belonging to two divisions namely the blue-green algae division and the division of green algae, the total number of diagnosed blue-green algae was(63) taxonomic unites while the diagnosed green algae were nine taxonomic units. Five species of blue green algae were recorded for the first time in Iraq belonging to four genera. During the study, some physical and chemical factors for the soils of the study sites were also measured, air temperature was (22.1-44.1)c° while the soil temperature ranged(16.3-33.9)c°,as for the electrical conductivity was ranged(4.77-7.42)ds m^{-1}while the salinity ranged(3.05-4.75)gm/l,and the rang of pH was(7.0-7.85).,nitrogen was ranged(7.16-30)mg/l, phosphorus (1.96-6.2)mg/l, and the potassium(104.91- 260)mg/l (table1).As for the texture of the soil it was silt clay. The results of the statistical analysis showed that there were significant differences between theacademic months with respect to air and soil temperatures, pH ,electrical conductivity,salinity, and nutrients at probability level $p \leq 0.05$,air and soil temperatures were directly associated with electrical conductivity and salinity and inversely with nutrients and numbers of algae species.

Table (1): Shows the values of the physical and chemical soil factors of the study sites of the Shatt Al-Arab district during the study period

Month	A.T	S.t	pH	E.C	Sal	N	p	K
Nov.	27.2	22.8	7	4.77	3.05	7.96	5.46	187.21
Jan.	22.1	16.3	7.85	4.98	3.19	7.16	5.38	127.21
Mar.	28.1	23.3	7.6	4.90	3.13	25	5.74	213.77

May.	37.4	28.6	7.3	5.12	3.28	30	6.2	260
Jul.	43.3	33.9	7.78	7.42	4.75	15.04	1.96	104.91
Sep.	44.1	32.4	7.2	5.76	3.68	16.71	2.62	113.77

Table (2): Shows the algae identified in the study area of Shatt Al-Arab site for and different months

Months / Algal species	Nov	Jan	Mar	May	Jul	Sep
Division:Cyanophyta						
Lemmer *Anabaena cylindrica*	-	-	-	+	-	+
Bornet *A.sp*	-	-	-	-	+	-
Aphanocapsa biformis A.Braun	+	-	-	-	-	-
Arthrospira platensis (Nordst.) Gomont	-	-	-	+	-	-
Asterocapsa sp	-	-	-	-	+	-
Borzia trilocularis Cohn	-	-	-	-	+	-
Chlorogloea cf.novacekii	-	+	+	-	-	-
C.microcystoids Geitler	-	-	-	+	-	-
Chroococcus minor (Kuetzing)	-	+	-	-	-	-
Naegeli (Ktz.) *C.turgid*	-	+	+	+	-	-
Gloeocapsopsis chroococcaides Komarek	+	-	-	-	-	-
Gloeotheca sameoensis Wille	-	-	-	+	-	-
Gomphosphira lacustris Chodat	-	+	+	+	-	-
Komvophoron constrictum Szafer	-	+	+	-	-	-
(Van Goor) Meffert *Limnothrix redek*	-	-	+	+	-	-
M.E . Meffert *L.sp*	-	-	+	-	-	-
Lyngbya aestuarii (Mert) Liebmann	+	-	-	-	-	-
Lemmer *L.hieronymusii*	-	-	-	-	+	-
L.limnetica Lemmermann	+	-	-	+	-	-
L.major (Menegh)	-	-	-	+	-	-
Curren et Biswas *L.regalis*	+	-	-	+	-	+
L.taylorii Drouet & Strickland	-	-	-	+	-	-
L.truncicola (Chose)	+	-	-	+	-	-
L.wollei (Spezial &Dyck)	-	-	-	-	+	-
.C.Agardh &Gomont *L.sp*	+	-	+	-	-	-
Microcoleus chthonoplastes (Thuret ex Gomont)	-	-	+	-	-	-
Kuetzing *Microcystis aeruginosa*	-	-	+	+	-	-
Kutzing *M.sp1*	-	-	-	+	-	-
Oscillatoria amoena (Kutz.) Gomont	+	-	-	-	-	-
O.anguina (Bory) Gomont	-	-	+	-	-	-
O.brevis (Kutz.) Gomont	+	+	+	-	-	+
O.curviceps Ag. Ex Gomont	+	-	+	+	+	+

Kuetzing *O.irrqua*	+	-	-	-	+	-
O.limosa Ag.ex Gomont	+	+	+	+	+	+
Vaucher *O.major*	-	-	-	+	-	-
O.ornata (Kutz.) ex Gomont	+	-	-	+	-	-
O.perornata Skuja	-	-	-	-	-	+
O.princeps Vaucher ex Gomont	-	-	-	-	-	+
O.rubscens DC ex Gomont	-	-	+	-	-	-
(Biswas) *O.salina*	-	-	+	-	-	-
O.sancta (Kutz.) Gomont	-	-	-	-	+	-
O.simplissima Anagnostidis & Komarek	-	-	-	-	-	+
O.tenuis Ag. ex Gomont	+	+	+	+	-	-
O.vizagaptensis (Rao,C.B)	-	-	-	-	-	+
O.sp1 Gomont	-	+	+	+	-	-
O.sp2	-	-	+	-	-	+
O.sp3	-	+	-	-	-	-
Gomont *Phormidium ambigium*	-	+	-	+	-	-
(Ag.)Gomont *P. autumnal*	-	-	-	+	-	-
(Kutzing ex Gomont) *P.breve*	-	-	-	+	-	-
Gomont *P.corium*	-	-	-	+	-	-
Gomont *P.formosum*	-	-	-	-	-	+
(Naeg.) Gomont *P.incrustatum*	-	-	-	-	-	+
P.foveolarum (Mont.) Gomont	-	+	-	-	-	-
p.tinctorium (A,B- Kirisnas I,2009;C- Verkne,2010)	-	-	-	-	-	+
P.tenue (Menegh.) Gomont	-	+	-	+	-	-
Planktothrix agardhii Komarek	-	-	-	-	-	+
Pseudanabaena frigida (Fritsch)	+	+	+	-	-	-
P. galeata (Bocher)	-	-	-	+	-	+
P.limnetica Komarek	-	-	+	-	-	-
.Lauterborn *P.sp*	-	-	+	-	-	-
Spirulina major (Kutz)	-	-	-	-	-	+
S.menegniana (Zanard. Ex Gomont)	-	-	-	+	-	-
Division:Chlorophyta						
Characium acuminatum (A-Braun)	-	-	+	-	-	-
Gloeocystis major (Gerneck)	-	+	-	-	-	-
.Nageli ex Braun *Oocystis sp*	-	-	-	-	+	-
Scendesmus bijugatus (Turp.) lagerheim	-	+	+	-	-	-
S.quadricuda Var.longispina (Chod) G.M	+	-	-	+	-	+
.Meyen *S.sp*	-	-	-	+	-	-
Stichococcus bacillaris Neageli	-	-	+	-	-	-
Ulothrix tenuissima (Kutzing)	-	+	-	-	-	-
(Turp) Ktz *u.sp1*	-	-	-	+	-	-
Number of algal species	16	17	24	30	10	17

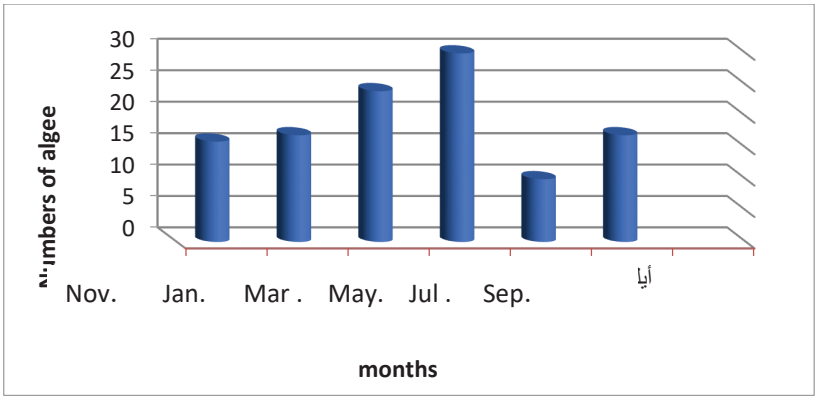

Figure (2): Shows the appearance of algal species for the study sites and months

The results showed that there is clear difference in the appearance of algal species in different months , it was noted that the month of May had the highest number of algal species, reaching 30 taxonomic units, followed by March with 24 taxonomic units, and the lowest was in July when the number of algal species appeared in it
eached 20 taxonomic units. The results also indicated that there was a variation in the appearance of algal species during the study period.The while other species disappeared in certain periods and reappeared in other periods and some appeared in short periods of time, the *Oscillatoria limosa* type appeared in all months, and the types that appeared in most of the academic months were *Oscillatoria brevis ,O.curviceps* and *O.tenuis*

Table(3): Pearson correlation coefficient(r) between the physical and chemical properties and the number of algae at the study site

Variants	A.T	S.T	EC	Sal	pH	N	P	K	San	Silt	Clay
A.T	1										
S.T	0.981**	1									
EC	0.669**	0.674**	1								
Sal	0.16-	0.673**	0.999**	1							
pH	0.118	0.125	0.496*	0.497*	1						
N	0.204	0.243	0.040	0.039	0.206	1					
P	0.587**-	-0.584**	0.407*-	0.407*-	0.137-	0.292	1				
K	0.057-	0.035-	0.236-	-0.237	0.227-	0.677**	0.628**	1			
San	0.068	0.093	0.185-	-0.183	-0.136	0.383-	0.550**-	-0.499*	1		
Silt	0.064-	0.089-	0.209	0.206	0.150	0.359	0.532**	0.463*	-0.998**	1	
Clay	0.072-	-0.97	0.159	0.157	0.120	0.408*	0.568**	0.537**	-0.998**	0.992**	1
N. sp	-0.244	-0.245	-0.468*	-0.468*	-0.55	0.610**	0.680**	0.781**	-0.287	0.253	0.323

**.Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Discussion:

The results of the study showed that there are clear monthly changes in the air temperature, which were directly reflected in the soil temperature, which appeared through the significant

correlation(r=0.981)(table3), the highest values were observed during the long summer months and the lowest during the short winter months this is due to the nature of Iraq climate in general being cold , rainy in winter and hot , dry in summer(Fahad,2006).Changes in soil temperature during the months of the year were associated to some extent with changes in air temperature. Temperatures greatly affected algal diversity during the study period and this was evident through the negative correlation(r=-0.245)(table 3),between the temperature and the nature of the algal diversity as the lowest diversity was recorded in July when the temperatures were high, and the highest diversity was in the month of May when the temperatures were moderate. The lack of diversity in the month of July is caused by high temperatures as well as an increase in the concentration of salinity and its high pH values, which are among the factors affecting the growth of algae while moderate temperatures means decrease in the concentration of salinity as well as a decrease in the pH values. The results of the current study agreed with the study of (Al-Salkhi,2017)about the soils of rice farms in Al-Diwaniyah Governorate, which indicated decrease in algal diversity in July and differed with it in the increase in algal diversity during September not May. Also showed that is a clear role for nutrients in determining the emergence of algal species .The statistical analysis showed that there are significant differences in the values of available nitrogen between the months of the year as the values recorded significant increase during the month of March and this may be due to the use of nitrogen fertilizers used for some crops grown in the study areas and perhaps the reason is due to the moderate temperatures and low salinity values in this month compared to other months, it was also noted that the lowest rate of ready nitrogen was at the month of January it may be attributed to the lack of algal diversity in this month it helped in lowering the nitrogen concentration because some blue-green algae that have the ability to fix nitrogen disappeared or decreased this month and thus affected the nitrogen concentration, the results of the study also showed decrease in phosphorus values during the month of September and perhaps the reason is due to the high temperatures in this month, which led to the adsorption of the phosphorus ion by the soil particles, and thus it is difficult to re-melting it (Weiner,2000),this is confirmed by the negative correlation between phosphorus and temperature(r=-0.58) (table3) this was accompanied by decrease in the number of algal species as phosphorus is an essential nutrient in the growth of algae (King&Word,1977),this was confirmed by the positive correlation between phosphorus and algae numbers(r=0.68) it was also observed that the phosphorus values increased in the month of May and the reason may be the use of phosphate fertilizers for some crops grown for growth when phosphate fertilizers(Westin &Buntley,1966), the statistical analysis also showed that there are significant differences in potassium values between the months of the year, the results showed an increase in its values during the month of May other months of the study and the reason may be due to the use of fertilizers containing potassium compounds (N-P-K) in addition to the moderate temperatures and salinity in this month ,as it was noted that there is a negative inverse correlation between potassium and high temperatures and salinity(r=-0.035,r=-0.237)respectively (table3).

The results of the study showed that there were differences in the number of diagnosed species for the months of the study the largest number of algae was recorded in the spring and the lowest in the summer perhaps this is due to the nature of algae in their response to changes in environmental conditions throughout the year such as temperature ,salinity, acidity, abundance and lack of nutrients, the results of the current study did not agree with the study(Al-Salkhi,2017)it was the highest variety in the Autumn and lower it in the spring ,the diagnosis of the largest number of algae in the spring, may be attributed to nutrient accumulation during the spring months, this was confirmed by the results of the current study of

the existence of a significant positive relationship between algal diversity and the nutrients represented by nitrogen,phosphorus and potassium (r=0.61), (r=0.68) and (r=0.78) respectively (table3).

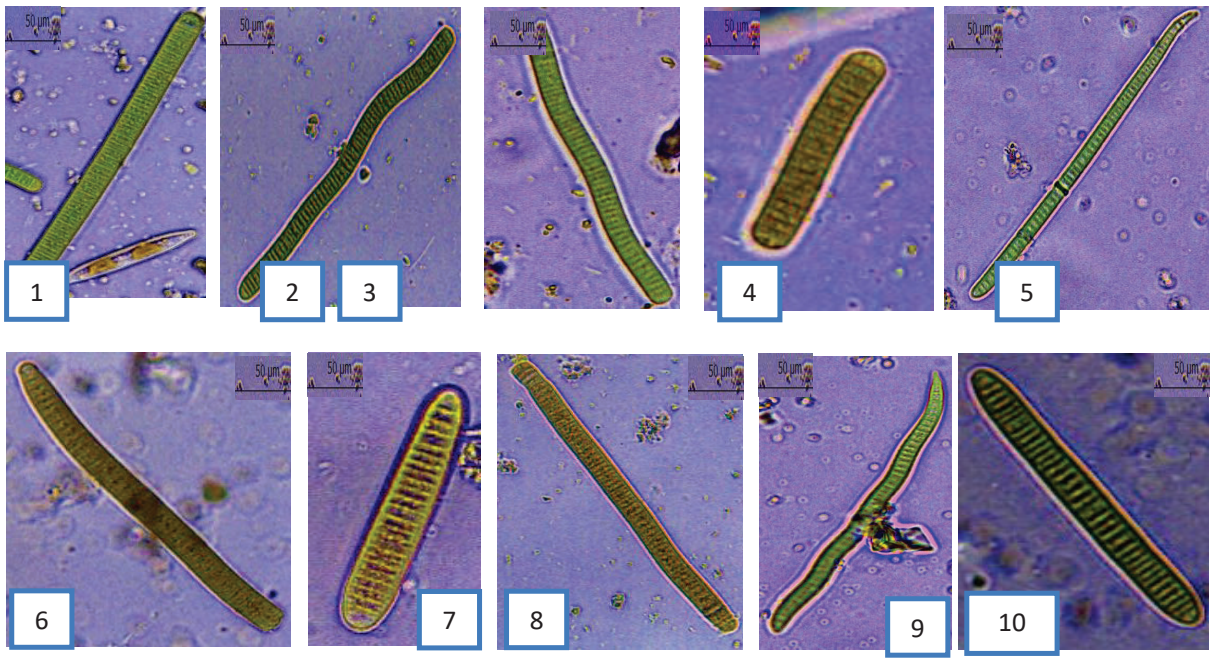

Figure (3): 1:*Oscilltoria limosa*. 2-3:*O.tenuis*. 4:*O.curviceps*. 5:*O.brevis*. 6:*O.sancta*. 7:*O.*anguina. 8:O.sp$_1$. 9:O.sp$_2$. 10:O.sp$_3$.

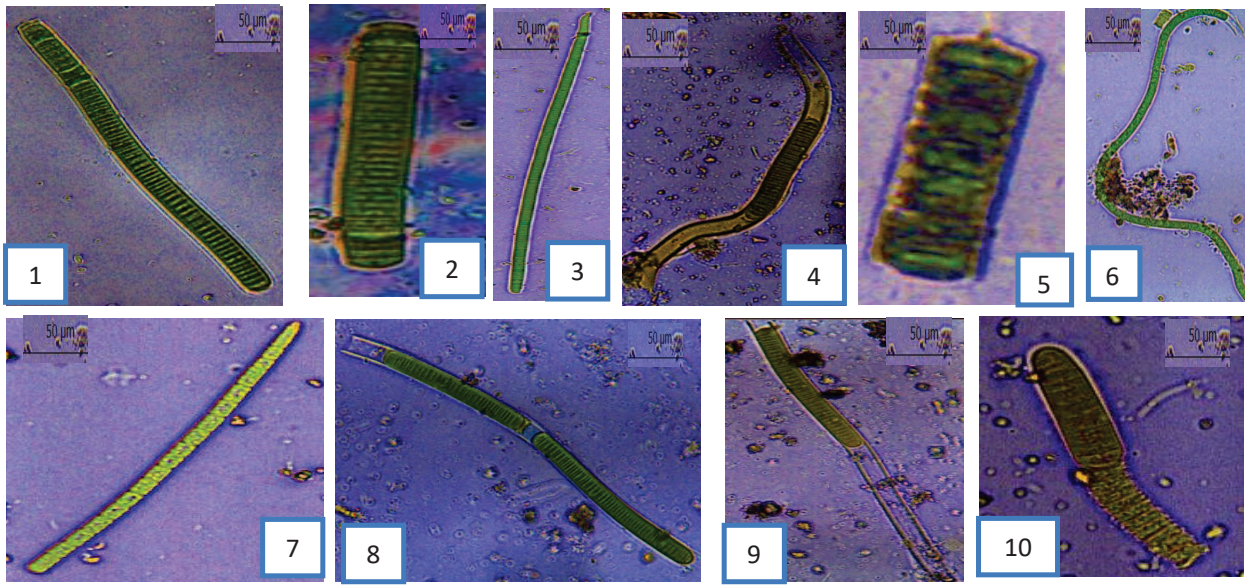

Figure (4): 1-2:*Oscilltoria princeps*. 3:*O.salina*. 4:*Phormidium ambigium* .5:*Ph.breve* .6:*Ph.corium*. 7:*Ph.tinctorium*. 8:*Lyngbya.aestuarii*. 9:*L.wollei*. 10:*L.regalis*

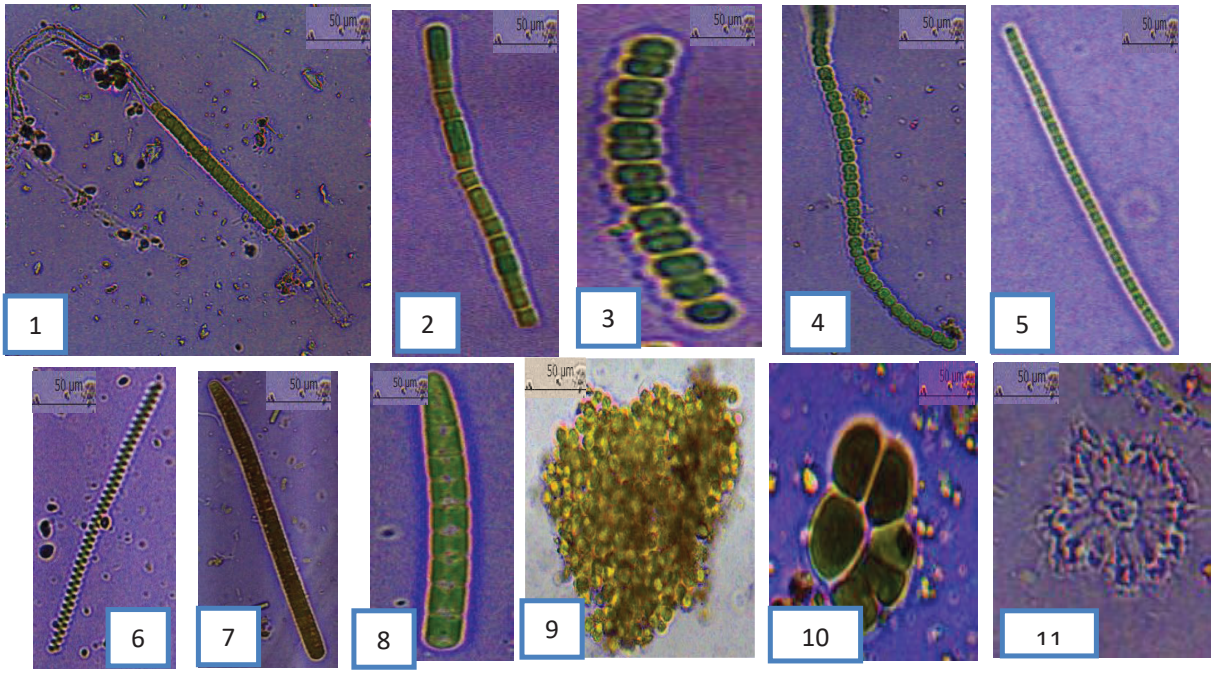

Figure (5): 1:*Lyngbya sp*. 2-4:*Anabaena cylindrica*. 4:*Pseudanabaena limintica*.. 5:*Spirulina major*. 6:*Planktothrix agardhii*. 7:*Ulothrix sp*. 8:*Microcystis aeruginosa*. 9:*Gloeocapsopsis chroococcaides*. 10:*Gomphosphera sp*

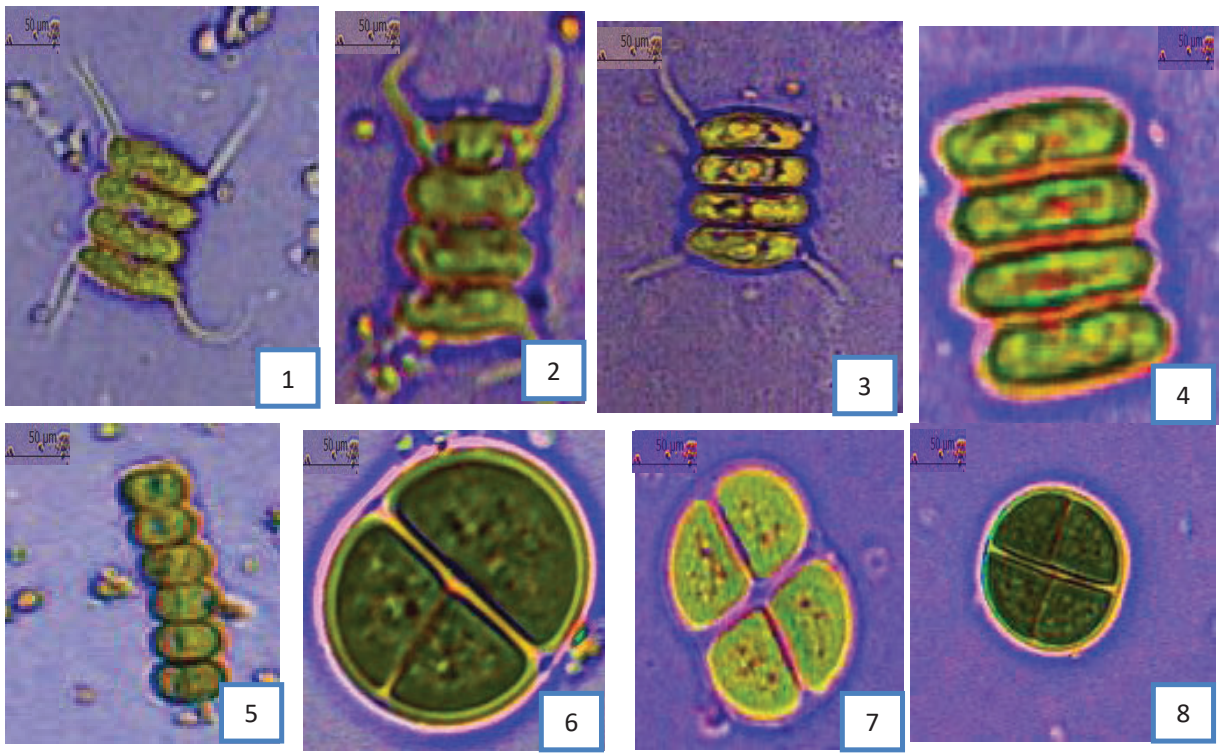

Figure (6): 1-3:*Scendesmus quadricuda*. 4:*S.bijugatus*. 5:*S.sp*. 6-8:*Chrococcus turgid*

Conclusion:

1-Blue-green algae are dominant in the study site and for all seasons of the year, followed by green algae.
2-The dominance of the species of the genus *Oscillatoria sp* over the rest of the algal species in the study site
3-Algae bloom was in the months of May and March ,and the lowest in July, as it was the least blooming

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