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PLANKTONIC COMMUNITY OF ALGAE IN SAWA LAKE, SOUTHERN IRAQ

Amal Fawzi Hasan*, Ithar Kamil Abbas Al-Mayaly[1] and Taha Yaseen Farhan[2]

* Ministry of Science and Technology, Baghdad, Iraq.
[1]University of Baghdad, College of Science, Iraq.
[2]Sawa Lake and Desert Studies Center, Al-Muthanna University, Iraq.

Abstract

Approximately 228 taxa of planktonic algae were identify, which includes: Bacillariophyceae composed of 42.54% Pennales and 2.19% Centrales, represented by 97 genus Pennales and 5 genes Centrales, followed by Cyanophyceae composed of 32.46%, represented by 74 genus. Chlorophyceae composed of 14.91%, represented by 43 genus. Euglenophyceae, and Pyrrophyceae composed of 3.51%, represented by 8 genus. Chrysophyceae was present during winter only, formed 0.87%, represented by two genus.

It was noticed that the numbers of algae fluctuated among studied stations and seasons, where winter was characterized by large number of algae 476 genus, the highest value 58 genus, 134 species was reported in station 5, the lower number 45 genus, 85 species reported in station 2. 474 genus, and higher number 54 genus, 125 species was recorded in station 4 during summer, the lower value 33 genus, 55 species was reported in station 5. In autumn, about 443 genes were identified. The highest value 62 genus, 116 species in station 2. But the lower value 31 genus, 56 species was noticed in station 1, whereas spring characterized by 343 genus, the highest value 47 genus, 94 species was mention in station 5, the lower value 29 genus, 43 species in station 1.

Key words: planktonic algae, fluctuated, Sawa Lake, Southren Iraq.

Introduction

Sawa lake located at the eastern edge of the southern desert of Iraq, 22 Km to the west of the Euphrates river, about (23 km) to the west of Al-Samawa city, between longitudes (44° 59 29 E and 45° 01 46.61E) and Latitudes (31° 17 43.10 N, and 31° 19 49.79N). The maximum length of the lake is about (4.74 km) but the maximum width of (1.77 km) isolated by gypsum barrier with total path (12.5 Km) surrounded the lake. It doesn't have a clear geometrical shape, but it tends to be pear-like (Hassan, 2007).

Only short data has been given on the phytoplankton composition of Sawa Lake. The past observational studies of (Hassan *et al.*, 2006) were study phytoplankton qualitatively and quantitatively as well as measuring the chlorophyll-a concentration, and noted that phytoplankton diversity was low, Al-Saadi *et al.*, (2008 b) stated that the lake dominated by Bacillariophyceae, followed by Cyanophyceae and Chlorophyceae, while only two species of Euglenophyceae were observed. The plankton, benthic and attached diatom community was investigated by Al- Handal (1994) who found the diatom population is a surprising mixture of brackish and freshwater diatoms which were not previously known to thrive in brackish habitats, 116 taxa were recorded mostly dominated by *Achnanthes brevipes*.

Environmental conditions in Sawa Lake have changed considerably during the last three decades because of a threefold salinity increase. Such a remarkable change in the lake's water quality led to the disappearance of several taxa and the appearance of new ones with different environmental preferences (Al-Handal *et al.*, 2014, 2016 a).

Al-Handal *et al.*, (2014) was recorded a new species of the genus *Cocconeis, Cocconeis sawensis* sp.nov. observed as epiphyte on the macrophyte *Chara* Linn.

***Author for correspondence :** E-mail : ammalhasanj@yahoo.com

sp. collected from this saline lake. Also, in 2015 he is recorded two new species of the genus *Mastogloia, Mastogloia sawensis* sp.nov. and *M. vestigiostriata* sp.nov. were encountered as epiphytes on *Chara sp*. which covers the sediment of Sawa lake. Also, in 2016a, b he recorded new epiphytes on the charophyte, *Lamprothamnium* sp., which dominates the lake's bottom, *Mastogloia abnormis* and *M. descrepata* a new taxa to Iraq or the science.

Material and Methods

Five stations were chosen in different areas and directions of Sawa Lake. Table 1 shows the latitudes and longitudes coordination for each sampling sites stations coordinates by using the Global Positioning System (GPS) which fixed on map (fig. 1).

Table 1: Sampling station positions

No.	Symbol	Coordinates	
		North	East
1	ST.1	31º 18' 22.7"	45º 01' 01.6"
2	ST.2	31º 19' 16.9"	45º 00' 26.5"
3	ST.3	31º 19' 49.5"	44º 59' 55.5"
4	ST.4	31º 18' 23.9"	44º 59' 57.9"
5	ST.5	31º 17' 44.5"	45º 01' 23.8"

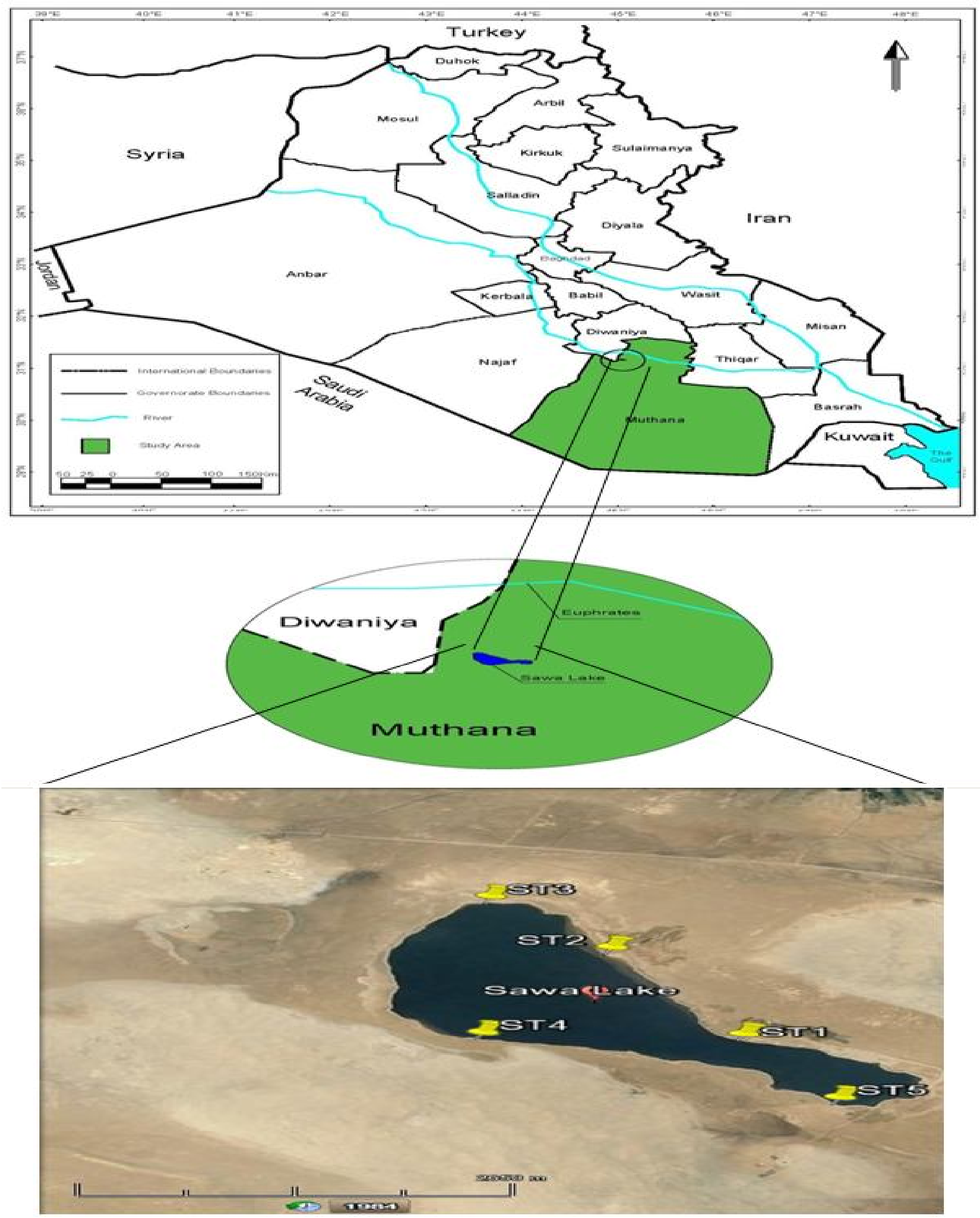

Fig..1: Sawa Lake map show coordination for each sampling sites (taken from Google)

Table 2: List of phytoplankton identification in Sawa Lake

Division: Chlorophyta Class : Chlorophyceae		
Order: Chlorococcales	**Order: Chlorococcales**	
Ankistrodesmus falcatus (Corda) Ralfs	*Golenkinia paucipinia West &West*	*Scenedesmus bijugatus* (Trup) Ktz.
Ankistrodesmus braunii. (Naeg.) Brunnther	*Golenkinia radiate (chod.)Wille*	*Scenedesmus denticulatus* Lagerheim
Chlorella ellipsoidea Gerneck	*Kirchneriella obese G.S.West*	
Chlorella Vulgareis Bejerinck	*Monoraphidium contractum Thuret*	**Order: Zygnematales**
Coelastrum microporum Naeg	*Monoraphidium griffil*	*Spirogyra novae-angliae* Transeau
Order: Volvocales	**Order: Oedogoniales**	**Order :Ulotrichales**
Chlamydomonas angulesa Ehrenberg	*Oedogonium cardiacum* (Hass.)	*Ulothrix aequalis* Ktz.
Chlamydomonas polypyreoideum Prescott	**Order: Chlorococcales**	
Chlamydomonas snowiae. Printz	*Oocystis eremosphaeria* G.M.Smith	
Order:Zygnematales	**Order: Volvocales**	
Cosmarium bioculatum de Brebisson	*Pandorina morum.*	
Cosmarium depresum. (Naeg.) Lundeii	**Order :Ulothrichules**	
Cosmarium meneghinii de Brebisson	*Radioflum flavescens* G.S. West	
Cosmarium reniforme (Ralfs) Archer	*Tetradesmus wisconsinense.*	
Cosmarium subtumidwn Var.Kwangsiense	*Stigeoclonium flagelliferum*	
Order: Ulothrichales	*Selenastrum minutum*	
Geminella interrupta Turp. Lagh.	*Scenedesmus arcuatus* Lemm.	
Order:Volvocales	*Scendesmus quadriqadi*	
Gloeocystis major Gerneck	*Scenedesmus dimorphus* Ktz.	
	Class :Bacillariophyceae	
Order :Centrales		
Aulecoseira varains	*Diatoma elongatum* Bory	*N. rhynchocephala*
Cyclotella meneghiniana Kützing	*Diatoma vulgare*	*N. tantula* (Grun.) Cleve
C. comta. Var.digactis (Her.) Grunow	*Eunotia bidentula.* (Ehr.) Grunow	*N. viridula*
C. ocellata Pantocsek	*Eunotia lunaris* (Ehr.) Grunow	*Nitzschia amphibian* Grunow
Stephanodiscus dubius (Fricke) Hustedt	*Fragilaria capucina* Desmazieres	*N. apiculata (Greg.)* Grunow
Order : Pennales	*F. brevistriata.* Var .inflata (pant.)	Hustedt *N. acicularis.* Kützing
Achnanthes affinis. Grunow	*F. intermedia* Grunow	*N. clausii* Hantzsch
A. brevipes	*F. vaucheriae*	*N. dissipata*
A. delicatula (Ktz.) Grunow	*F. virescens*	*N. fasciculata* (Grun.)Grunow
Amphora coffaeiformis (Ag.)Kuetzing	*Gomphonema acuminatum* Ehrenberg	*N. filiformis* (W.Smith)Var.Heurck
Amphora veneta Kuetzing	*Gyrosigma auenuam*	*N. frustulum.*
Amphora ovalis	*G. gracile* Ehrenberg	*N. gracilis* Kützing
Amphipleara pellucida (Ktz.) Kuetzing	*G. tenuirostrum*	*N. granulatea* Grunow
Bacillaria paxillifer. (Muell.)Hendey	*Mastogloia elliptica* (Ag.) Cleve	*N. hantzschiana.*
Caloneis amphisbaena.	*Mastogloia smithii* Var. Lacustris Grunow	*N. heufleriana.* Gran.
C. permagna (Bail) cleve	*Melosira sp.*	*N. intermedia.*Hantzsch Cleve et Grun
Cocconeis placentula Ehrenberg	*Melosira italic.*	*N. lorenziana*
Cocconeis pediculus Ehrenberg	*M. granulate*	*N. linearis* (Ehr.) W. Smith
Cymatopleura solea.	*Navicula anglica* (Ehr.) Kützing	*N. minutula*
Cymbella obtusiuscula	*N. bacilloides*	*N. pusilla* (Ktz.)Grunow
*Cymbella aspera. (*Ehr.)	*N. brekkaensis* variete. Andegavensis	*N. palea* (Kütz.) W. Smith
Cymbella affinis Kützing	*N. cuspidate*	*N. subcapitellate* Hustedt
Cymbella cistula.	*N. fraglaroides* Krasske	*N. rostellata* Hustedt
Cymbella tumida	*N. grimmei* Krasske	*N. romana* Grunow
Cymbella parva. (W.Smith)Kitchn	*N. halophila* var. robusta of. subsapitata Oestrup	*N. sigma*
Cymbella prostrate.	*N. hungarica* Grunow	*Surirella pulchella*
Cymbella caespitosa	*N. lanceolata*	*Synedra acus* var. radians Kützing

Table 2 continued...

Table 2 continued...

Cymbella Helvetica	*N. pupula*	*Synedra adamsii* Kützing
Diploneis psudovalis	*N. radiosa* Kuetzing	*Synedra rumpens*
Synedra ulna var. danica (Ktz.) Van Heurck		
Synedra tabulate Var.fascicalata (Kutz.) Grunow		
*Stauroneis phenlcenteron. (*Nitz.) Ehrenberg		
Division: Cyanophyta		
Order: Chroococales		
Blue-green filaments.		
Aphanothece bullosa	*Dermocarpella hemisphaerica*	*Myxosarcina burmensis* Skuja
A. castagnei. (Breb.)Rabenhorst	*Gomphosphaeria aponina* Kuetzing	
Order :Chroococales		
A. microscopica Naegeli	*Gomphosphaeria lacustris.* Var. compacta.	*Merismopedia tenuissima Lemmermann*
A. nidulans .var.endophytica.	*Gloeothece rupestris* (Lung.) Bornet	*Merismopedia punctata* Heyen.
Order : Nostocales *Anabaena constricta*.(Szafer) Geitler	*Gleocapsa . stegophila* *Gloeocapsa rupestris* Kutz.	*Microcystis aeruginosa* Kutzing *Microcystis flos-aquae* (Wittr.) Kirchner
Anabaena cylindrical Lemmer.	*Gloeocapsa montana* Kutz.	*Microcystis marginata* (Menegh) Kuetzing
Order :Chroococales	*Gloeocapsa pleurocapsoides* Novacek	*Microcystis orissica*
Aphanocapsa muscicola (Menegh) Wille	*Gloeocapsa quaternaria* Kuetzing	**Order: Nostocales**
Aphanocapsa montana Gramer	*Haematococcus lacustris.*	*Nostoc carneum* Agardh
Aphanocapsa littoralis Hansigirg	**Order : Oscillatoriales**	*Nostoc piscinale* Ktz.
Chroomonas nordstedtii	*Lyngbya aestuarii* Lammermann	*Nostoc muscorum* Agardh
Chroococcus pallidus Naegeli	*Lyngbya earlei* gardner	*Nostoc calcicola.*
Chroococcus minor (Ktz.)Naegeli	*Lyngbya gardneri.* Setchell &Cardner Geitler	
Chroococcus varius A.Braun	*Lyngbya nordgaardii* Wille	
Chroococcus montanus Hansgirg *Lyngbya limnetica Lemmer.*		
Chroococcus minutus (Kitz.)Naegeli *Lyngbya mesotrica. Skuja*		
Order: Oscillatoriales	*Lyngbya sp.*	**Order :Chroococales**
Oscillatoria acutissima (Kufferath) Gomont	*O. prolifica* (Grev) Gomont	*Synechococcus aeruginosus Naegli*
O. angustissima West &West	*O. pseudogeminata* Var. unigranulate Biswas	*S. elongatus Naegli*
O. earlei gardner	*O. princeps* Vaucher	
O. curviceps Agaedh	*Phormidium ambiguum* Gomont	
O. formosa Bory	*Ph. corium* Gomont	
O. homogenea Fremy	*Ph. Laminosum* (Gom.)ex. Gomont	
O. limnetica Lemmermann	*Ph. molle* Gomont	
O. lacustris (Klrbahn)Geitler	*Ph. Tenue* (Menegh) Gom.	
O. limosa Roth Agardh	*Ph. purpurascens* Kuetz.	
O. minima Gicklhorn	*Spirulina laxa* G.M. Smith	
O. minnesolensis Tiden.	*Spirulina major* Ktz.	
O. sancta	*Schizothrix lacustris* A. Braun	
O. subbrevis Schmidle		

Table 2 continued...

Table 2 continued...

O. proteus Skuja *O. tenuis*		
Division :Chrysophyta **Class : Xanthophyceae**	**Division :Pyrrhophyta** **Class :Dinophycea**	**Division :Euglenyta** **Order :Euglenales**
Oeder : Mischococcales	*Ceratium hirundinella* (Muell) Du Jardin	*Euglena* oxyuris Var.minor De Flandra
Chlorellidiopsis separabilis Pascher	*Glenodinium armatum* Levander	*Euglena acus*
Ophiocytium paraulum Folle	*G. borgei. (*Lemm.)Schiller	*Euglena elastic* Prescott
	G. gymnodinium Penard	*Phacus pyrum*
	G. pulvisculus (Ehr.) Stein	*Trachelomonas pulcherrima* .var. minor
	Peridinium cinctum. Var.tuberosum.	*Trachelomonas lacustaris* Drezepolski
	*Peridinium pusillum (*Penard) Lemm.	*Trachelomonas similis.*
	Peridinium inconspicuum. Lemm.	*Trachelomonas volvocina* Ehr. *Trachelomonas sp.*

Phytoplankton, samples were taken 50 cm below the water surface. For Quantitative Study, total number count of Phytoplankton was performed by use sedimentation method, one liter from each station was taken in a measuring cylinder (1000 ml), samples were preserved by adding 2ml of Lugol's solution with 40% formaldehyde , and left in stand place, after 10 days, 900 ml were sucked by siphon method. The rest was transported to another cylinder (100 ml) and left to sediment for one week, after that 90 ml withdrawn and the rest (10 ml) put in covered glass container with adding acidic Lugol's solution and kept refrigerated in dark until analysis (Furet and Benson-Evans, 1982).

For the non-diatoms identified were done by taking a drop of preserved sample on a haemocytometer, and then examined using a compound microscope (x10, x40 and x100). For diatom identification, permanent slides were made using Canada balsam and a hot plate, followed by use the microtransect method for counting diatoms (Stein, 1975). A non-diatomic algae was identified depending on Desikachary (1959); Prescott (1982); Komarek (1983); Van vuuren *et al*., (2008) While diatoms were identified depending on Czarnecki *et al*., (1978); Germain (1981); Hadi *et al*., (1984); Al-Handal (1994).

Results and Discussions

Approximately 228 taxa of planktonic algae were identified in such water system, the majority of which have not been reported before in lake and some of these species was added recently to Iraq's algae flora by Al-Hussieny and Thijar (2016 a) such as *Nitzschia minutula, Navicula tantula, Phacus pyrum.* Table 1 describes list of phytoplankton species that recorded in Sawa lake waters during the period from (February, 2016- March, 2017).

Quantitative analysis led to observed relatively abundant groups were present for the most period of the study containing Bacillariphyceae (97 genus of Pennales, 5 genus Centrales). The pennate diatoms are present in significant numbers in the lake, and represented 42.54% of the total diatoms, in some instances were recorded in all season. While centric diatoms formed only 2.19 % of the total diatom, presented by *Cyclotella meneghiniana, C. ocellata, C. comota, Stephanodiscus dubius*, and *Aulecoseira varains*.

Many researches have pointed out the abundance of diatoms in Iraqi surface water and explained that the diatoms had the ability to alter the conditions of their environment, but their community structure responded to altered physiochemical and biological variable in the ecosystem (Hassan and Shaawiat, 2015). Such as the study of (Al-Husseiny *et al*., 2013; Al-Husseiny, 2018) improved the ability of diatom *Navicual busiedtii* to decreasing salts from salty water with different concentration depending on diatoms ability for growing and reproduction at salty water environment.

74 genus of Cyanophyceae were recorded with relative abundance 32.46% of planktonic community, but the dominate species represent with *Oscillatoria sp.* for the most period and sites (table 3). Chen *et al*., (2016) studied saline Chagan Nur Lake in the southeastern part of China's and stated that *Oscillatoria limnetica* functional groups have strong tolerance to adapt to high-salinity water, shallow water habitats, and are distributed through a wide range of the habitat.

Chlorophyceae represented by 43 genus, their relative abundance was 14.91%, possessed dominant species usually found in lake such as *Radioflum flavescens*.

Some desmids frequently observed in this alkaline

Table 3: Dominance species of planktonic algae during (February, 2016-March, 2017) in all five stations.

Seasons			
Winter	**Spring**	**Summer**	**Autumn**
Chlorella sp.	———-	———-	———
Chlamydomonas sp.	———-	———-	*Chlamydomonas sp.*
Cosmarium sp.	*Cosmarium sp.*	———-	———-
————-	———	*Pandorina morum*	———
Radioflum flavescens	*Radioflum flavescens*	*Radioflum flavescens*	*Radioflum flavescens*
Scendesmus sp.	———-	———-	*Scendesmus sp.*
Cyclotella sp.	———-	*Cyclotella sp.*	———-
Caloneis sp.	————	————	*Caloneis sp.*
Cymbella sp.	————	*Cymbella sp.*	*Cymbella sp.*
————	———-	*Fragilaria sp.*	———-
Melosira sp.	———-	*Melosira sp.*	———-
———-	*Navicula sp.*	*Navicula sp.*	*Navicula sp.*
Nitzschia sp.	*Nitzschia sp.*	*Nitzschia sp.*	*Nitzschia sp.*
Pinnularia sp.	———-	*Pinnularia sp.*	*Pinnularia sp.*
Peronia sp.	———-	———-	———-
———-	*Synedra sp.*	*Synedra sp.*	*Synedra sp.*
Blue-green filaments	*Blue-green filaments*	*Blue-green filaments*	*Blue-green filaments*
Aphanocapsa sp.	———-	———-	*Aphanocapsa sp.*
Chroococcus sp.	*Chroococcus sp.*	*Chroococcus sp.*	*Chroococcus sp.*
Lyngbya sp.	———-	*Lyngbya sp.*	———-
———-	———-	*Gleocapsa sp.*	———-
Myxosarcina sp.	———	———	———-
———	*Nostoc sp.*	———-	———-
Merismopedia sp.	———-	———-	———-
Oscillatoria sp.	*Oscillatoria sp.*	*Oscillatoria sp.*	*Oscillatoria sp.*
———	*Phormidium sp.*	———-	*Phormidium sp.*
———-	———	———-	*Spirulina sp.*
———	———-	———-	*Synechococcus sp.*
Trachelomonas sp.	———	———-	——————
——————-	———-	———	*Glenodinium sp.*
———	———	———-	*Peridinium sp.*
20 species	**10 species**	**15 species**	**18 species**

habitats were never recorded in lake before such as *Cosmarium bioculatum, C. depresum, C meneghinii, C. reniforme* and *C. subtumidium*, although the pH recorded during study range from 8-8.9. This may be explained by (Van Vuuren *et al*., 2006) who stated that desmids is most common in acidic, oligotrophic, aquatic habitats, but may also occasionally be found in alkaline, eutrophic, ponds and lake or in sub-aerial environments, such as the remarkable ability of the desmid to survive and recover from desiccation for period up to 6 months was described by (Brook and Williamson, 1990).

All studied of Iraqi inland water such as (Salman *et al*., 2013; Kadhim, 2014; Al-Husseiny *et al*., 2016b) showed that the number of identified Chlorophyta species in fresh water were much more than the number of Cyanophyta species, the opposite case showed in Sawa lake this may attribute to the fact that blue green higher tolerance to salinity. Our result also confirm by Al-Saadi *et al*., (2008a,b).

However, other species observed capable to withstanding the highest salinities, both Euglenyta and Pyrrhophyta represented by 8 genus, and relative abundance 3.51%. Rare species belong to Chrysophyta were present during winter only such as *Chlorellidiopsis separabilis,* and *Ophiocytium paraulum*, in relative abundance formed only 0.87%, until now has not been recorded in Sawa lake before, is not excluded to be introduced to lake by migrated birds which are known to be important vectors for long-distance transportation of aquatic organisms depended on (Kristiansen,1996).

Distribution of phytoplankton in the lake

Phytoplankton abundance was highest in winter

Table 4: Number of genus and species of phytoplankton in all studied stations during winter.

Algae Taxa	ST.1		ST.2		ST.3		ST.4		ST.5		Total	
	G	Sp.	G	Sp.	G	Sp.	G	Sp.	G	Sp.	Sp.	%
Bacillariophyceae												
A-Centrales	1	1	2	3	1	2	1	2	3	2	10	2.10
B-Pennales	15	33	18	44	17	41	13	22	22	66	206	43.28
Cyanophyceae	16	32	9	15	15	27	17	35	17	39	145	30.46
Chlorophyceae	12	16	13	17	12	13	10	14	11	17	77	16.17
Pyrrophyta	1	1	2	3	1	1	3	4	2	4	13	2.73
Euglenophyceae	2	4	1	3	2	4	2	4	2	5	20	4.20
Chrysophyceae	-	-	-	-	2	2	2	2	1	1	5	1.05
Total	**47**	**87**	**45**	**85**	**50**	**90**	**48**	**83**	**58**	**134**	**476**	**99.99**

G. =genus, Sp. =species

Table 5: Number of genus and species of phytoplankton in all studied stations during spring.

Algae Taxa	ST.1		ST.2		ST.3		ST.4		ST.5		Total	
	G	Sp.	G	Sp.	G	Sp.	G	Sp.	G	Sp.	Sp.	%
Bacillariophyceae												
A-Centrales	1	1	1	1	1	1	2	3	1	1	7	2.06
B-Pennales	12	20	6	12	17	33	18	59	22	55	179	52.19
Cyanophyceae	10	15	9	17	15	32	10	15	10	20	99	28.86
Chlorophyceae	5	6	6	9	11	13	4	5	10	13	46	13.41
Pyrrophyta	-	-	-	-	1	1	-	-	1	1	2	0.58
Euglenophyceae	1	1	-	-	2	4	1	1	3	4	10	2.92
Chrysophyceae	-	-	-	-	-	-	-	-	-	-	-	-
Total	**29**	**43**	**22**	**39**	**47**	**84**	**35**	**83**	**47**	**94**	**343**	**100**

G. =genus, Sp. =species

Table 6: Number of genus and species of phytoplankton in all studied stations during summer.

Algae Taxa	ST.1		ST.2		ST.3		ST.4		ST.5		Total	
	G	Sp.	G	Sp.	G	Sp.	G	Sp.	G	Sp.	Sp.	%
Bacillariophyceae												
A-Centrales	2	2	1	2	1	3	2	4	1	1	12	2.53
B-Pennales	18	54	15	42	18	56	18	50	19	33	235	49.58
Cyanophyceae	19	45	16	28	10	20	16	31	9	17	141	29.75
Chlorophyceae	10	17	10	13	10	11	13	17	3	3	61	12.87
Pyrrophyta	3	5	3	4	2	2	3	4	-	-	15	3.16
Euglenophyceae	2	2	1	1	1	2	3	4	1	1	10	2.11
Chrysophyceae	-	-	-	-	-	-	-	-	-	-	-	-
Total	**54**	**125**	**46**	**90**	**42**	**94**	**55**	**110**	**33**	**55**	**474**	**100**

G. =genus, Sp. =species

(table 4) when water temperatures are at or around 19ºC, to explain this may be due to dilution of water salinity, and also because of lower temperature values in winter, zooplankton are largely absent from the lake and thus grazing pressure on the phytoplankton community is low, also high concentration of nitrate was recorded in winter especially in January.

These results generally supported the conclusion which a nitrogen limitation phytoplankton growth in brackish water which improved by (Hassan *et al*., 2008) who studied the phytoplankton population dynamics in Sawa lake when subject to enrichment by nitrogen and phosphorus.

According to studied sites, the highest species of algae 134 species belong to 58 genus were recorded in station 5 during winter, but the lowest species 83 species belong to 48 genus were recorded in station 4 which lie near the hole that feed lake with water. Relative abundant of Pennales, Cyanophyceae, Chlorophceae, Euglenophyceae, Pyrrophyta, and Chrysophyceae were recorded 43.28%, 30.46%, 16.17%, 4.20 %, 2.73% and 1.05%, respectively.

Table 7: Number of genus and species of phytoplankton identification in all station during autumn.

Algae Taxa	ST.1		ST.2		ST.3		ST.4		ST.5		Total	
	G	Sp.	G	Sp.	G	Sp.	G	Sp.	G	Sp.	Sp.	%
Bacillariophyceae												
A-Centrales	-	-	3	3	2	2	2	2	2	2	9	2.03
B-Pennales	8	22	21	49	15	29	20	39	19	46	185	41.76
Cyanophyceae	15	25	21	39	5	6	20	37	19	41	148	33.41
Chlorophyceae	6	6	13	19	11	14	10	13	7	14	66	14.90
Pyrrophyta	2	3	3	5	3	8	2	5	2	6	27	6.09
Euglenophyceae	-	-	1	1	2	2	2	4	2	1	8	1.81
Chrysophyceae	-	-	-	-	-	-	-	-	-	-	-	-
Total	**31**	**56**	**62**	**116**	**38**	**61**	**56**	**100**	**51**	**110**	**443**	**100**

G. =genus, Sp. =species

In spring, the highest species of algae 94 species belong to 47 genus were recorded in station 5, the lowest species 43 species belong to 29 genus were recorded in station 1, probably due to an increased in zooplankton number, also a connection between increasing salinity in the lake and decreased in numbers and relative abundance of phytoplankton. The lowest relative abundant in planktonic algae compare to other season was recorded to the number of cyanophyceae 28.86%, and pyrrophyta 0.58% (table 5).

Table 6, explain the results which recorded through summer, the highest number of species 125 species belong to 54 genus were recorded in station 1, the lowest species number 55 species belong to 33 genus were recorded in station 5. The lowest relative abundance of Chlorophyceae 12.87% was recorded in summer compared to other season. Fakioglu (2013) reported that the light and temperature play a significant role in the relationship between the extinction rate and biomass and carrying capacity of the composition of species.

In autumn, the highest number of species 116 species belong to 62 genus were recorded in station 2, the lowest number of species was 56 species belong to 31 genus were recorded in station 1. These result may attributed to West monsoon in November which result to aggregate planktonic algae in station 2. The lowest relative abundant of Pennales 41.76% (Bacillariophyceae), and Euglenophyceae 1.81% was recorded in autumn compare to other season. Also, the highest relative abundant of Pyrrophyta 6.09% was recorded in autumn compared to other season (table 7).

The total biomass in all stations and seasons in current study was 96973 cell/l (table 8) which belongs to 6 division: Bacillariophyta, Cyanophyta, Chlorophyta, Pyrrhophyta, Euglenophyta and Chrysophyta with biomass 46703, 29070, 17021, 2337, 1732, 110 cell/l respectively. The relative abundant of total biomass was 48.16%, 29.97%, 17.55%, 2.40%, 1.78%, 0.11% respectively.

Also, table 8 illustrated that the phytoplankton biomass showed less equally distribution between stations. The highest total numbers of algae 21538 cell 10^3/l were recorded in station 5, while the lowest total number of species17701 cell 10^3/l were recorded in station 3. These result possibly attributed to the seasonal and diurnal monsoons combined with waves which can generate a certain mechanism lead to distribution patterns of nutrient and algae in the lake.

Shifts in Algae Community in Sawa Lake

The current study may provide evidence that the changed in ionic concentration and salinity after 24 years from first study in 1994, drive selection, and this selection is intimately associated with shifts in both within individual taxa and across the entire algae community.

A relatively large number of taxa encountered in current study have not been previously reported in the lake. Mohammad (2005) stated that the algae flora of the lake were dominate by *Chara canescens*, blue green algae which represented by on species *Nodularia* sp., and two diatom *Synedra ulna* and *Mastogloia*.

Hassan *et al*., (2006) also found some species were not recorded before in the lake by Maulood and Al-Mausawi (1989), and stated that phytoplankton diversity is low and composition is dominated by a total of 51 algal taxa was identified, 33 species belong to Bacillariophyceaem (4 species Centrales and 29 species Pennales), Cyanophyceae 12 species, chlorophyceae 4 species, and Euglenophyceae 2 species. Diatoms were dominated in species number 64.7% and total cell number (68.6%) followed by blue green 23.5% and total cell number 15.5%, the green 7.8% and total cell number 14.5% and Euglenoids 4.0%.

Al-Saadi *et al*., (2008a) found that three species were the most dominant in total cell number (5%) in all station

Table 8: Biomass of identified plankton algae (cell 10^3/l) in all study seasons and stations.

Algae Taxa	Stations					Total Biomass
	ST.1	ST.2	ST.3	ST.4	ST.5	
Chlorophyta						
Winter	932	735	482	1290	1225	4664
Spring	1034	2800	742	125	1077	5778
Summer	549	789	411	1291	45	3085
Autumn	365	1048	683	825	573	3494
Total	**2880**	**5372**	**2318**	**3531**	**2920**	**17021**
Bacillariophyta						
Winter	1704	1407	1408	830	3829	9178
Spring	2377	1291	2142	2464	2894	11168
Summer	1930	2268	2814	2882	2883	12777
Autumn	3156	2804	3347	1716	2557	13580
Total	**9167**	**7770**	**9711**	**7892**	**12163**	**46703**
Pyrrhophyta						
Winter	12	171	18	83	64	348
Spring	0	0	21	0	34	55
Summer	187	141	68	189	0	585
Autumn	215	264	432	180	258	1349
Total	**414**	**576**	**539**	**452**	**356**	**2337**
Cyanophyta						
Winter	2068	606	1025	1610	1472	6781
Spring	974	951	1271	466	1205	4867
Summer	1901	1648	1129	1744	1665	8087
Autumn	1619	2495	1335	2614	1272	9335
Total	**6562**	**5700**	**4760**	**6434**	**5614**	**29070**
Chrysophyta						
Winter	0	0	34	44	32	110
Spring	0	0	0	0	0	0
Summer	0	0	0	0	0	0
Autumn	0	0	0	0	0	0
Total	**0**	**0**	**34**	**44**	**32**	**110**
Euglenyphyta						
Winter	86	84	89	159	158	576
Spring	32	0	157	11	163	363
Summer	112	29	38	119	32	330
Autumn	0	26	55	282	100	463
Total	**230**	**139**	**339**	**571**	**453**	**1732**
Total Biomass	**19253**	**19557**	**17701**	**18924**	**21538**	**96973**

during their study of lake, namely *Chlorella vulgaris, Scenedesmus bijuga* and *Cyclotella meneghiniana*, the presence of some filamentous green algae was also noticed in their studied such as *Cladophora crispata*, *C. fracta*, and *Chara* sp.

Al-Handal *et al*., (2014; 2015) examine that diatoms population of Sawa lake change with salinity and other salts shift after two decades from the first taxonomical study and stated that 95% of the diatoms encountered in 1994, have been replaced by other taxa, some of them have not been seen elsewhere and may be new species and some others have been recorded thousands kilometer away. Such as *Williamsella iraqiensis* was found on the sediment of the lake as solitary cells and also, but rarely, as epiphytes on *Chara* spp. which covers the lake bottom (Al-Handal *et al*., 2016 b).

It seems that at higher salinities, many of the rarer species disappear either as a result of the inability to phylogically overcome osmotic stress or by being outcompeted by species less affected by osmotic stress (Larson and Belovsky, 2013).

It is possible to see the presence of rare diatoms able to with stand the increased conductivity and capitalizing on the opportunity to grow in a condition considered too harsh for other diatoms. In this case, they would have a competitive advantage in the new environment and this may be an indication that they are weak competitors in lower salinities (Cohen, 2010).

Also, the present study appears, that *Cyclotella meneghiniana* widely distributed in the fresh and brackish waters of Iraq decreased in number, and *C. striata*, *Aulecoseira granulate* was not recorded in current study possibly may replace by *Aulecoseria varains*. The ecological succession which noted in many water systems improved that the *Cyclotella* sp. was the first algae which increased in number in the end of year side by side with *Melosira* sp. (Boney, 1975).

The decreased in the number of *Cyclotella* sp. may be probably due to competition with *Melosira* sp., or possibly the salinity has a significant influence on the likelihood of diatom species to colonize an area Cohen (2010). Heavy concentrations of salt ions may disrupt the ability of some diatoms to osmoregulate more so than others and would therefore restrict these species from flourishing. It has been demonstrated that certain species are more likely to persist in higher salinities while others will have optima at lower conductivities.

Also, Saros and Jasmine, (2000) reported that salinity and brine type (sulfate- versus bicarbonate-dominated) may influence the ability of diatoms to obtain sufficient nitrogen (N). Certain diatoms, such as *Cyclotella meneghiniana*, produce amino acids such as proline for osmoregulation. Because amino acids contain N, the stimulation of proline synthesis may affect N requirements. Hence, as salinity increases, diatoms that synthesize proline or other amino acids as osmotic regulators should require more N, and confirm the impact of brine type on NO^3 use;

This is consistent with the theory that sulfate inhibits molybdate uptake, as molybdenum is required for NO^3 use.

Amphora ovalis, and *A. veneta* which were found rarely in plankton sample of Sawa Lake during 1994, frequent apparent in all season in current study. *Cymatopleura solea* wide spread in Iraq, can be found in water of relatively high salinity, rare in grab sample of Sawa lake in 1994, was frequent occurred in all season in current study.

Eight species of *Cymbella* was found in current study represented by *C. affinis, C. cistula, C. helvetica and C. tumida* were recorded in 1994, and *C. aspera, C. caspitosa, C. parva,* and *C. prostrate* were frequent in current study. Five species of *Fragilaria* represented by *F. capucina, F. vaucheriae* recorded in 1994, and *F. brevistriata, F. intermedia, F. virescens* were frequent in present study.

Fourteen species of *Navicula* species were frequent in present study included *N. anglica, N. bacilloides, N. brekkaensis, N. cuspidate, N .fraglaroides, N. grimmei, N. halophile, N. hungarica, N. lanceolata, N. rhynchocephala, N. tantula, N. viridula*, while *N. pupula* , and *N. radiosa* was rare in grab and scrapped sample recorded in 1994.

Twenty three species of the genus *Nitzschia sp*. occures in all seasons. *N. amphibia, N. dissipata, N. frustulum, N. granulata, N. palea, N. sigma* which recorded in 1994 were frequently occurs in current study, perhaps it was the most halotolerant eukaryotic organisms known. *N. dissipata*, and *N. frustulum* which was rare in scrapped sample in 1994 were frequent occurs in present study.

From two *Pinnulara* species (*P. interrupta* and *P. viridis*) that were recorded by Al- Handal (1994), only *P. viridis* occurs in all season of current study possibly due to this species was rarely plankton, other 8 species *P. appendiculata, P. borealis, P. leptosome, P .lata, P. major, P .mesolepta, P. molaris* were not recorded in the lake before.

Only *Rhopalodia gibba* recorded in present study while *R. musculus* frequent in every sample examined from Sawa Lake in 1994 was not recorded in present study.

Conclusion

Higher diversity of planktonic algae community in Sawa Lake was found, the dominant species of algae identification in past was succeed one another by disappear some species and are replaced by other and some species may introduced recently to the lake. However, phytoplankton cell numbers were higher in winter and coincided with high nitrate availability which played an important role in biomass of algae communities in this saline lake.

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