Algal Survey in Wastewater Channel of Erbil City, Iraq

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Abstract

The present study describes the algal assemblages at 3 sites within Erbil wastewater channel which extended from southwest of Erbil city with their elongation for more than 50 km effluent discharges into Greater Zab River, with particular reference to abundance, distribution and periodicity were investigated in the samples collected. A total of 56 taxes was identified belongs to 3 divisions, among them 26 taxa were belong of Bacillariophyta, 18 taxa were Cyanophyta and 12 taxa were Chlorophyta. The seasonality of algal assemblage was decreased at 3 sites within Erbil wastewater channel in January and February-2011. The dominate genera among non-diatoms were, ***Oscillatoria, Merismopedia Chroococcus, Ulothrix, Scendesmus*** **and** ***Spirogyra*** whereas among the diatoms were ***Navicula***, ***Syndra, Gomphonema***, and ***Fragilaria***, have been studied, in addition to many environmental parameters such as water temperature, pH, electrical conductivity (EC), phosphate, sulfate, nitrate dissolved oxygen and BOD_5 were evaluated to explain the effect of these parameters on algal distribution in waste water channel in Erbil city.

Keyword: Erbil wastewater channel, Algae, community structure.

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مسح الطحالب في قناة مجاري مدينة أربيل، العراق

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الخلاصة

تصف الدراسة الحالية مجتمعات الطحالب في 3 مواقع داخل قناة مياه الصرف الصحي في مدينة أربيل التي تمتد من جنوب غرب مدينة وذلك لتصريف النفايات السائلة الى أكثر من 50 كم الى نهر الزاب الاعلى، مع إشارة خاصة إلى وفرة وتوزيع وتواجد الطحالب من خلال التحري عنها في العينات التي تم جمعها. تم تشخيص 56 نوع تنتمي الى ثلاثة شعب، و كالاتي 26 نوع منها تعود الى الدايتومات، و 18 نوع تعود للطحالب الخضر المزرقة و12 نوع تعود الى الطحالب الخضر. وقد انخفض اعداد تجمعات الطحلبية في 3 مواقع داخل قناة مياه الصرف الصحي شهري كانون الثاني وشباط 2011. الاجناس السائدة التي تم دراستها لغير الدايتومات هي ***Oscillatoria***، ***Chroococcus Merismopedia***، ***Ulothrix***، ***Scendesmus*** و***Spirogyra*** في حين بين الدياتومات كانت **Navicula**, ***Syndra, Gomphonema***, ***Fragilaria*** التي تم تشخيصها، بالإضافة إلى العديد من العوامل البيئية مثل درجة حرارة الماء، ،درجة الحموضة ،التوصيل الكهربائي ،الفوسفات ،الكبريتات ،النترات ،الأوكسجين المذاب والمتطلب الحيوي للاوكسجين التي تم تقييمها وذلك لتوضيح تأثير هذه العوامل على توزيع الطحالب في قناة مياه الصرف الصحي في مدينة أربيل.

كلمات مفتاحية: قناة مجاري أربيل، الطحالب، تركيبة المجتمعية

Introduction

Water is a common element in lives of all peoples and societies. Water has been foundation of many great civilization and today is essential for the agriculture, economic and industrial activity that helps societies and develop (1). The pollution of water sources happens through point and non-point source. Non-point source pollution is more ambiguous which cannot be related to a specific point for example, pesticides and fertilizers application to agriculture fields (2). The problem of water pollution occurs when substances are added to the water that affect its chemical composition and threaten the human health and ecosystem (2). Agricultural land, sewage effluent, debris, runoff from urban areas, and animal waste, are found to be responsible for the increased number of microorganisms found in water (3). Wastewater is the largest disposal problem associated with waste and by-product production, being typically several tones of water per person per year (4). Physical, chemical and biological parameters are important characters to recognized wastewater quality (5). The phytoplankton play an important role in aquatic ecosystems. They are the primary producers, thus they are the first link in the food chain, and often cause nuisance condition to the environment (6). As stated by (7) algal flora is an important indicator of water pollution and bloom in water bodies receiving agriculture waste, domestic water and household waste. Algae particularly diatoms are generally accepted as one of the most suitable bioindicators of aquatic ecosystem for water quality monitoring and organic pollution (8). Specific algae grows in specific environments and therefore, their distribution pattern, periodicity and productivity are different vary from water to water body. However, algal species, community structure, fine spatial distribution and biomass vary day to day, season to season as affected by environmental factor (9). Although, the composition of phytoplankton community has been changed little in the past 10 years especially, Cyanophyta because they are extremely very stress to environmental conditions (10).The objective of this work is to analyze of the physical, chemical variables and algal composition of heavily polluted wastewater channel to get a better understanding of these influences to water quality.

Materials and Methods

Erbil wastewater channel which extended from southwest of Erbil city with their elongation for more than 50 km passes through vast farmlands, orchards and several villages, after Gameshtapa village wastewater effluent discharges into Greater Zab River. Generally, Erbil sewer system is constructed for storm water and in most cases domestic sewers are connected illegally with storm sewer. The width of channel ranges from 2-4m with depth more than 1m at different locations (11). In present investigation, triple water samples were collected regularly on monthly basis from 3 sites along Erbil wastewater channel (the distances between each sites is more than 10km) during May 2010- April 2011 (Table 1, Figure 1).

Standard techniques were used (12) to analyze the different physico- chemical parameters: water temperature was measured in the field with a mercury thermometer (0-50 °C) graduated up to 0.1 intervals, at the depth 20cm, pH, electrical conductivity measured in field by using (pH meter Philips 4014 and EC meter Philips 4025 respectively), SO_4^{2-} (turbidimetric method), dissolved oxygen concentration (DO) and Biological oxygen demand (BOD_5) was determined using azid modification of winkler method, PO_4^{3-} using ascorbic acid reduction method, NO_3 by Cadmium-copper reduction method was used for nitrate determination. While, algal samples were collected in different sites from water samples, epipelic, epilethic and epiphytic of polluted channel. Identification of algal species were done by using the following identification keys (13, 14, 15, 16, 17, and 18).

Table (1) GPS data of each wastewater sample sites.

Sites	locations	X(UTM)	Y(UTM)	Z(altitude) m.a.s.l
1	Swery (bridge)	400541	4001279	339
2	Qadrya	379609	3998922	255
3	Hawera	373688	3997723	237

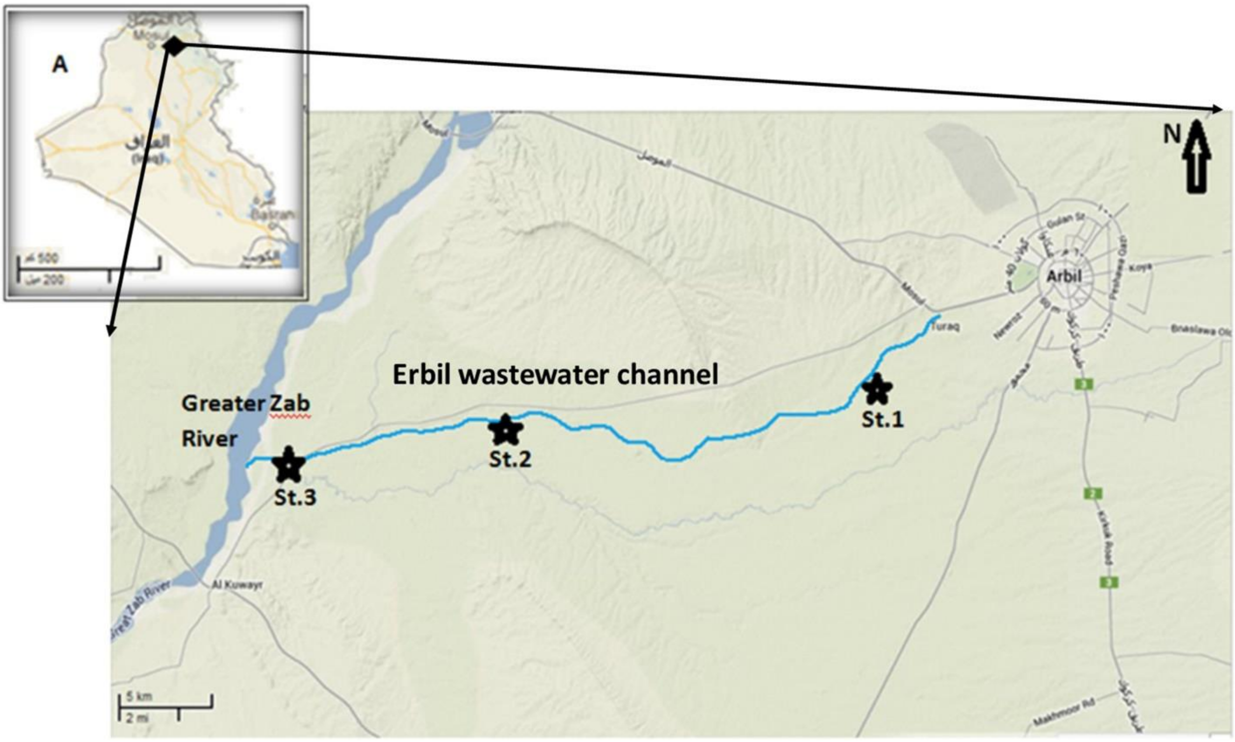

Figure (1): Map showing A: Iraq, B: Southwest of Erbil governorate, and sampling sites along the Erbil wastewater channel (Google earth).

Results and Discussion

The environmental characteristic of the wastewater in the current study is shown in (Table 2). The water temperature reached its high value (28 ºC) in site 1 during January and its lowest value (8 ºC) in site 3during August. Similar conclusion observed by (19, 20 and 21). Narrow fluctuation of pH was observed during the study period, with their tendency to alkaline side of neutrality, the highest average value of 8.1 recorded in site 3 and lowest value 7.0 in site 1, this may be related to the high amount of detergents with alkaline nature in neutrality discharge from domestic uses into sewage channel. Same reason was reported by (11) during their study on the same area. pH level we're concerned with minimum discharge and maximum phytoplankton abundance, while the number of algal species increased with pH (22). These results match with many other studies of (11, 21, and 23) at the same polluted channel. The results showed high conductivity values ranged between (455 $\mu s \cdot cm^{-1}$) in site 1 as lower value and (1020 $\mu s \cdot cm^{-1}$) in site 3 as high value, this may be attributed to pollutant discharged from agricultural area around this site, and it mainly depending upon the degree of mineralization, temperature, soil discharge of agricultural and industrial wastewater and geological formation (24). Similar results were found in many previous studies conducted by several researchers in Erbil wastewater channel.

The concentration of dissolved oxygen ranged from 0.2-4.8 $mg.l^{-1}$ at sites1 and 3 respectively. There was an increase in dissolved oxygen in cold months at all the study sites. The concentration of dissolved oxygen was affected by many factors especially biological activities such as photosynthetic, respiration and decomposition process in addition to the rainfall effects (25). The concentrations of BOD_5 ranged from 4.5 to 104 $mg.l^{-1}$ recorded in site 3 and site 1 respectively. These concentrations may be attributed to the observed human activities such as washing, dumping of refuse and houses discharge organic wastes continuously, as this test reflect the amount of the organic waste (26). The lower concentrations of BOD_5 may be due to the dilution effects of rainfall, lower water temperature which coincided by low microbial activities during this period, this records of variable were similar than what was found by other researchers, who studied the same location (20 and 27).

Table (2) Some water quality characteristics for Erbil wastewater channel, data represented as meam ± Standard Error with minimum andmaximum values.

Variables	Site 1	Site 2	Site 3
Temperature °C	19.7± 1.55 10- 28	18± 1.43 8.5- 27	18± 1.23 8- 27
pH	7.1± 0.05 7.0- 7.5	7.3± 0.03 7.1- 7.6	7.4± 0.08 7.3- 8.1
EC µs.cm^{-1}	615± 32.2 455- 825	643± 38.2 520- 915	725± 50.1 530- 1020
PO_4 µg $P.PO_4.l^{-1}$	720± 61.2 400- 1020	782± 63.1 442- 1035	790± 69.6 430- 1236
SO_4 $mg.l^{-1}$	918± 32.1 170- 1220	995± 40.5 279- 1221	1210± 45.8 277- 1963
NO_3 µg $N.NO_3.l^{-1}$	650± 240 3.2- 4020	1045± 310 5.5- 6453	780± 265 6.3- 1332
DO $mg.l^{-1}$	1.20±0.23 0.2- 3.3	2.1± 0.31 0.5- 4.2	3.1± 0.45 0.3- 4.8
BOD_5 $mg.l^{-1}$	75± 15.1 6.3- 104	28.1± 11.2 5.4- 100	30.1± 12 4.4- 95

Waste water samples of Erbil city appeared a sulphate range between (170-1973 $mg.l^{-1}$). However, the value of SO_4 showed pronounced local variation in each month this generally may be correlated with regional condition and human population in addition to the type of water sources and rainfall and to lithology of the catchment area [28]. Similar results were observed by (23). Nitrate value in this study varied between 3.2-6453 µg N- $NO_3.l^{-1}$.This may be due that nitrate levels depend on several factor such as the fertility of soil in the drainage basin, domestic sewage, mixing and rainfall (29). Our results were higher than what was found by other researchers who studied the area (19, 22, and 30). Phosphate is an important constitute of living organisms and often present in significant amounts, although it is needed in small amounts, but considered to be the more common algal growth limiting element (32 and 33). The variation of phosphate concentration in the studied area may be connected to, phytoplankton activities, and allochthonous inputs (31 and 32).

Algal community in Erbil wastewater channel is shown in (Tables 3, 4, 5, 6, 7, 8, 9 and 10) which consisted of a total of [56] taxes belonging to three taxonomical division; Bacillariophyta [26 taxa], Chlorophyta [12 taxa] and Cyanophyta [18 taxa]. Bacillariophyta were found in high percentage (46.43%) of total organisms and they were dominating species among the algal groups. Bacillariophyta was dominant followed by, Cyanophyta and Chlorophyta. In the present study the waste water showed a higher population of diatoms coincided with the ability to adaptation to any change around them than other types of algae (33). Similar observation was found by (34). Pennales diatom was the dominated group of diatoms [25 species] than central's diatoms in the present study, this might be due to high tolerance to wide environmental changes (33). It's clear that diatoms represented by 5 order 8 families and 14 genera. Also it is clear from a total of 26 diatom algal taxa was identified (Tables 9 and 10). (30) during their study on the same polluted channel identified 128 taxa, the Bacillariophyta was the most dominant group with (62 spp.), while, Euglenophyta was contributed only by (6 spp.). Bacillariophyceae was the dominant group because the members of Bacillariophyceae are sensitive to a wide range of limnological and environmental variables, and that their community structure may quickly respond to changes in the environmental condition. Algal community in most aquatic systems and diatoms have much to offer as fresh water bioindicators of aquatic ecosystem health, species like ***Gomphonema*** and ***Navicula*** are considered as pollution tolerant (35). ***Cocconeis*** require large concentration of inorganic nutrient (36). ***Gomphonema*** it is well known indicates deteriorates of water quality (37). While the species ***Amphora*** and ***Cocconeis*** were common in calcareous and slightly alkaline water. Algal community decrease at all stations in December and January. Despite it is known that during winter, low algal growth is due to low irradiance and low water temperature (38). Generally, algal densities were increased in spring and summer while algal number decreased in autumn and winter (39).

Table (3) The algal species recorded during the studied

Division: Cyanophyta	Family: Oocystaceae	*Cyclotella* Kuetz 1838	19-*C. tumida* Van
Class: Cyanophyceae	*Chlorella* Ehr 1822	*1-C. ocellata* Pant	20-*C. turgida* Kuetz
Order: Chroococcales	*1-C. vulgare* Ehr	Order: Fragilariales	21-*C. ventricosa* Kuetz
Family: Chroococcaceae	Family: Hydrodictyaceae	Family: Fragilariaceae	Family: Amphiproraceae
Chroococcus Naegeli 1949	*Pedistrum* Meyen 1829	Diatoma De Card 1805	Amphiprora Ehr 1890
1-C. minor Ktz	*2-P. boryanum* Turp	2-D. elongatum Lyngb	22-*A. paludosa* Ktz
2-C. prescotti Ehr	Family:Scendesmedaceae	3-D. hiemele Lyngb	Family: Gomphonemaceae
3-C. turgidus Ktz	*Scenedemus* Kuetz 1890	4-D. vulgare Bory	Gomphonema Cleve 1894
Merismopedia Meyen 1889	*3-S. abundans* Kich	Tabellaria Ktz 1890	23-*G. angustatum* Kuetz
4-M. elegans A Brun	*4-S. denticulata* Smith	5-T. fenestrata Ehr	24-*G. parvulum* Kuetz
5-M. Glauca Ktz	*5-S. Luytrix* Ktz	*6-T. floculosa Ehr*	Order: Surirellales
6-M. punctata Heyen	*6-S. quadricauda* Turp	Fragilaria Lyngb 1819	Family: Surirellaceae
7-M. tenuissima	Order: Ulotrichales	7-F. brevistriata Ehr	Cymatopleura Erh 1890
Order: Oscillatoriales	Family: Ulotrichaceae	8-F. capucina Demaz	25-*C. solea* Ehr
Family: Oscilatoriaceaea	*Ulothrix* Ktz 1849	9-F. construens Ehr	Surirella Turpin 1828
Oscillatoria Vaucher 1892	*7-U. tenussima* Ktz	10-F. leptostauron Ehr	26-*S. ovata* Ktz
8-O.angustissima Ehr	Order: Cladophorales	Synedra Ehr 1832	
9-O. amoena Gomont	Family: Cladophoraceae	11-*S. acus* Kuetz	
10-O. amphibia Gomont	*Cladophora* Ktz 1845	12-*S. ulna* Ehr	
11-O. articulata Gardner	*8-C. glomerata* Ktz	Order: Achnanthales	
12-O. limnetica Roth	*Stigeoclonium* Ehr 1890	Family: Achnanthaceae	
13-O. Santca Agardh	*9-S. lubricum* Ehr	Cocconeis Ehr1838	
14-O. spledida Greville	Order: Zygnematales	13-*C. plancentula* Ehr	
15-O. subbrevis Schmidle	Family: Desmidiaceae	Order: Naviculales	
16-O. tenuis Agardh	*Closterium* Ehr 1845	Family: Naviculaceae	
Family: Phormidiaceae	*10-C. lunula* Ktz	Grysosigma Hass 1895	
Spirulina Tupin	*Cosmarium* Lund 1890	14-*G. Scalproides* Cleve	
17-S. nordstedtti Gomont	*11-C. laeva* Ktz	Navicula Bory 1824	
Order: Nostocales	Family: Zygnemataceae	15-N. cuspidata Kuetz	
Family: Nostocaceae	*Spirogyra* Lewis 1927	Family: Cymbellaceae	
Anabaena Bory 1822	*12-S. dubia* Ktz	Amphora Ehr 1840	
18-A. planctonia Brun	Division: Heterokontophyta	16-*A. ovalis* Kuetz	
Division: Chlorophyta	Class: Bacillariophyceae	Cymbella Agardh 1830	
Class: Chlorophyceae	Order: Eupodiscales	17-*C. affinis* Kuetz	
Order: Chlorococcales	Family: Cosinodiscaceae	18-*C. minuta* Ehr	

Table (4) The distribution of non-diatom algal species among studies sites during the studied period.

Non diatom species	Sites		
	1 (Swery village)	2 (Abassyia village)	3 (Hawera village)
Chroococcus Naegeli 1949.			
C. minor Ktz	+	+	+
C. prescotti Ehr		+	
C. turgidus Ktz	+	+	
Merismopedia Meyen 1889			
M. elegans A Brun		+	+
M. Glauca Ktz	+	+	+
M. punctata Heyen	+		
M. tenuissima		+	
Oscillatoria Vaucher 1892			
O.angustissima Ehr			+
O. amoena Gomont		+	
O. amphibia Gomont	+		+
O. articulata Gardner	+	+	+
O. limnetica Roth	+		
O. Santca Agardh	+		
O. spledida Greville		+	
O. subbrevis Schmidle	+	+	+
O. tenuis Agardh	+	+	
Spirulina Tupin		+	+
S. nordstedtti Gomont	+		
Anabaena Bory 1822			
A. planctonia Brun		+	
Chlorella Ehr 1822			
C. vulgare Ehr		+	+
Pedistrum Meyen 1829			
P. boryanum Turp		+	
Scenedemus Kuetz 1890			
S. abundans Kich			+
S. denticulata Smith	+		
S. Luytrix Ktz			+
S. quadricauda Turp		+	
Ulothrix Ktz 1849			
U. tenussima Ktz	+	+	+
Cladophora Ktz 1845			
C. glomerata Ktz	+	+	
Stigeoclonium Ehr 1890			

S. lubricum **Ehr**			+
Closterium **Ehr 1845**			
C. lunula **Ktz**	+	+	
Cosmarium **Lund 1890**			
C. laeva **Ktz**	+	+	+
Spirogyra **Lewis 1927**			
S. dubia **Ktz**	+	+	+

+ = detected

Table (5) The monthly distribution of non-diatom algal species recorded during the studied period

Nondiatoms species	**Months**											
	2010								**2011**			
	May	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**
Chroococcus												
C. minor			+	+	+			+				
C. prescotti								+				
C. turgidus				+				+				
Merismopedia												
M. elegans			+			+		+				
M. Glauca			+		+	+						
M. punctata				+								
M. tenuissima						+		+				
Oscillatoria												
O.angustissima			+		+							
O. amoena											+	
O. amphibia					+	+						
O. articulata	+		+		+	+		+		+	+	+
O. limnetica						+						
O. Santca						+						
O. spledida						+						+
O. subbrevis	+	+	+	+	+				+		+	+
O. Tenuis					+	+	+	+			+	+
Spirulina								+				
S. nordstedtti												
Anabaena												
A. planctonia		+										
Chlorella												
C. vulgare								+			+	
Pedistrum												
P. boryanum				+								

Scenedemus												
S. abundans				+								
S. denticulata												
S. Luytrix					+							
S. quadricauda						+						
Ulothrix												
U. tenussima		+		+	+	+		+	+			+
Cladophora												
C. glomerata		+				+						+
Stigeoclonium												
S. lubricum		+										
Closterium												
C. lunula					+	+						+
Cosmarium												
C. laeva				+	+	+	+					
Spirogyra												
S. dubia			+	+	+	+					+	

Table (6) Total number and Frequency percentage of non-diatom species recorded during the studied period.

Genera	No. of species	Percentage %
Chroococcus	3	10
Merismopedia	4	13.33
Oscillatoria	9	30
Spirulina	1	3.33
Anabaena	1	3.33
Chlorella	1	3.33
Pediastrum	1	3.33
Scenedesmus	4	13.33
Ulothrix	1	3.33
Cladophora	1	3.33
Stigeoclonium	1	3.33
Closterium	1	3.33
Cosmarium	1	3.33
Spirogyra	1	3.33
Total	30	100

Cyanophyta community assemblage was recorded by 18 species with 32.14% and 5 genera of 4 families were recorded. Cyanophyta more than any other algae tolerant to organic pollution because they are highly resistant to all sorts of ecological stresses and environmental hardships When Cyanophyta occur in drinking water supplies and ability a serious health hazard to animals and human (40). The distribution of the ***Oscillatoria*** and ***Merismopedia*** species more abundant than others species during the studied period because they are more tolerant to organic pollution. On the other hand a single algal species like ***Spirulina*** during the studied period was found in site 3, ***Spirulina*** occurred in water containing high levels of carbon dioxide (9). However, ***Spirulina*** being not only used as a nutritive of fish or as a medicine but it is also used to remove heavy metals and bacteria in waste water (9).

Chlorophyta were represented by 9 genera and 12 species with 21.43% increase number of green algae was related to ecological condition. ***Stigeoclonium***, ***Chlorella*** and ***Scendesmus*** were observed in various sites, it is abundant in water with high levels of organic matter with responsible for cleaning water by removing nutrient. Moreover, the ability to grow in water polluted by heavy metals can be used as an indicator of Eutrophication (41). ***Closterium*** and ***Scendesmus*** exhibited higher sampling frequency in site 2, 3. It is emphasized; ***Cosmarium***, ***Closterium*** and ***Stigeoclonium*** were found in hard and very hard water (42).

Table (7) The distribution of diatom algal species among studies sites during the studied period.

Diatom species	Sites		
	1	2	3
Cyclotella **Kuetz 1838**			
C. ocellata **Pant**	+	+	+
Diatoma De Card 1805			
D. elongatum **Lyngb**	+		
D. hiemele **Lyngb**	+		
D. vulgare **Bory**	+	+	+
Tabellaria Ktz 1890			
T. fenestrata **Ehr**	+		
T. floculosa Ehr	+		
Fragilaria Lyngb 1819			
F. brevistriata **Ehr**			+

F. capucina **Demaz**	+		
F. construens **Ehr**	+	+	+
F. leptostauron **Ehr**	+		
Synedra Ehrenberg 1832			
S. acus **Kuetz**	+		+
S. ulna **Ehr**	+	+	+
Cocconeis Ehrenberg 1838			
C. plancentula **Ehr**	+	+	+
Grysosigma Hass 1895			
G. Scalproides **Cleve**	+	+	+
Navicula Bory 1824			
N. cuspidata **Kuetz**	+	+	+
Amphora Ehrenberg 1840			
A. ovalis **Kuetz**	+		+
Cymbella Agardh 1830			
C. affinis **Kuetz**	+	+	+
C. minuta **Ehr**			+
C. tumida **Van**	+	+	
C. turgida **Kuetz**	+	+	+
C. ventricosa **Kuetz**	+		
Amphiprora Ehr 1890			
A. paludosa **Ktz**			+
Gomphonema Cleve 1894			
G. angustatum **Kuetz**			+
G. parvulum **Kuetz**	+	+	+
Cymatopleura Erhernberg 1890			+
C. solea **Ehr**	+		+
Surirella Turpin 1828			
S. ovata **Ktz**	+		+

\+ = detected

Table (8) The monthly distribution of non-diatom algal species recorded during the studied period.

Nondiatoms species	**Months**											
	2010								**2011**			
	May	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**
Cyclotella												
C. ocellata	+		+									
Diatoma												
D. elongatum												
D. hiemele									+			
D. vulgare								+		+		+
Tabellaria						+			+			
T. fenestrata									+			
T. floculosa										+		
Fragilaria												
F. brevistriata		+										
F. capucina				+	+			+				
F. construens				+	+	+	+	+	+	+	+	+
F. leptostauron					+	+						
Synedra												
S. acus								+			+	+
S. ulna		+		+	+	+		+	+	+	+	+
Cocconeis												
C. plancentula	+		+	+	+	+					+	+
Grysosigma												
G. Scalproides			+	+	+				+	+	+	+
Navicula												
N. cuspidata			+	+	+	+	+	+	+	+	+	+
Amphora												
A. ovalis		+	+	+	+	+	+	+	+	+		
Cymbella												

C. affinis		+	+	+	+	+		+	+	+	+	+
C. minuta			+									
C. tumida				+	+	+		+	+			
C. turgida		+			+			+	+	+	+	+
C. ventricosa			+									
Amphiprora												
A. paludosa												
Gomphonema												
G. angustatum								+				
G. parvulum		+	+					+			+	+
Cymatopleura												
C. solea					+			+				
Surirella												
S. ovata					+			+			+	+

+ = detected

Table (9) Total number of diatom species with their frequency percentage recorded during the studied period.

Genera	No. of species	Percentage %
Cyclotella	**1**	**3.85**
Diatoma	**3**	**11.54**
Tabellaria	**2**	**7.70**
Fragilaria	**4**	**15.39**
Synedra	**2**	**7.70**
Cocconeis	**1**	**3.85**
Grysosigma	**1**	**3.85**
Navicula	**1**	**3.85**
Amphora	**1**	**3.85**
Cymbella	**5**	**19.23**
Amphiprora	**1**	**3.85**
Gomphonema	**2**	**7.70**
Cymatopleura	**1**	**3.85**
Surirella	**1**	**3.85**
	26	**100**

Table (10) Total number of algal species with their frequency percentage % recorded during the studied period.

Division	Classes	Order	Family	Genera	Species	Percentage %
Cyanophyta	1	3	4	5	18	32.14
Chlorophyta	1	4	7	9	12	21.43
Heterokontophyta	1	5	8	14	26	46.43
Total	3	12	19	28	56	100

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