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Assessment of the water quality of Um El-Naaj Marshes by Diatoms

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ABSTRACT

This study is to assess the water quality in Um El-Naaj Marshes which is used the Diatoms community as a bioindicator for assessing the water quality. Diatom indices {Trophic diatom index (TDI), Diatom index (DI), Generic diatom index (GDI)} about the status of the freshwater ecosystem. In this study, the epiphytic diatoms on host aquatic plants *Phragmites australis* were collected from six sites at Um El-Naaj Marshes from November 2018 to April 2019. A total of 155 diatom taxa were identified. The results have shown that families such as Naviculaceae 27.2%, 21.5%, 25.5%, 26.4%, 18.4%, 18.4% were the most dominant followed by Fragilariaceae 18.2, 10.7, 13.9, 16.9, 13.8, 13.8% respectively. The presence of these families indicates that the trophic status of the ranges from mesotrophic to eutrophic, and the Um El-Naaj Marshes is ranged from abundant to moderate, while the DI was moderately polluted or significantly eutrophicated.

Key words *: Epiphytic diatom, Water quality, Diatom indices, Um El-Naaj Marshes.*

Introduction

The marshes in the southern portion of Iraq are among the most prominent in the area that developed within the sedimentary plain, creating a natural equilibrium between the Tigris, the Euphrates, and Shatt al-Arab rivers leading to the Arab Gulf. The marshes represent an integrated ecosystem that dates back more than 5000 years and occupied a large area of southern Iraq (Garstecki and Amr 2011). The AL Hawaiza marshes lie between (31 and 31.75 latitudes) from the north. It extends between the Iraqi-Iranian borders, is called in Iran Hawr Al-Azim, but the marsh largest part lies in Iraqi side and extends from south Al Musharah in Maysan governorate to Qurnacity in the south, its city length (80 km) and its width (30 km) (Taylor *et al.*, 2011; Hassan *et al.*, 2012). Epiphytic diatom is living organisms that plays a role in aquatic ecosystems as primary producers (Graham *et al.*, 2009). Many authors focused on its importance where aquatic plants are a good shelter to grow algae and tolerance different environment conditions (Salman *et al.*, 2007). The importance of Epiphytic diatom in Iraqi aquatic ecosystems was subjected to investigations recently. Many authors have previously recognized benthic algae as bioindicators in different aquatic ecosystems of Iraq (Ács *et al.*, 2004; Graham *et al.*, 2009). Benthic diatoms are unicellular or colonial, free-living or attaching to the substratum by gelatinous extrusion and they are mostly associated with substrata throughout their life cycles (Salman *et al.*, 2007; Kadhim *et al.*, 2013). Diatoms are sensitive to a wide range of environmental variables, to changing physical factors such as sediment character, light, temperature, salinity and depth (Werner, 1977; Ács *et al.,* 2004; Kadhim *et al.,* 2013). The abundance of some diatomic species may reflect the status of the aquatic ecosystem such as the trophic status and organic pollution and to water quality (ÞAHÝN *et al.,* 2010, Kadhim *et al.,* 2013; Al-Hassany and Hassan, 2014). *Phragmites australis* (Cav.) Trin. Ex Steud stand is an emergent aquatic macrophyte plant that has immersed roots in the water and long steams, with obvious leaves, characterized by high vegetation abundance, high productivity, and grows widely in places (Meyerson *et al.,* 2016). It is from the aquatic plants that provide important role to the ecosystem as it serves in the purification of water, control of erosion, biofuels, construction materials (Kiviat, 2013), also important source for the cellulose and support the biodiversity as it provides shelters for the other living organisms (Köbbing *et al.,* 2013). AL-Hassany and Hindi, (2016) they found by study about the Epiphytic algae on *Phragmites australis* and Epipelic Algae on Tigris River in Al Dorra zone in Baghdad; the total number of Epiphytic algae was raised during winter and dropped in summer. In another study that included the qualitative analysis of epiphytic algae on living, dead stems and leaves of *P. australis* along Tigris River within Al-Jadria region in Baghdad during the period from autumn 2014 till summer 2015, the results recorded 8 new species and 142 taxa included: Bacillariophyceae 117 taxa, Cyanophyceae 13 taxa, Chlorophyceae 11 taxa and Rhodophyceae 1 taxa only (Al Hassany, Al Bayaty, 2017). The present study was performed since there was limited data for assessment water quality for Um El-Naaj Marshes by diatoms in Maysan, Iraq. So, this study aimed to assess the water quality of Um El-Naaj Marshes based on epiphytic diatoms by using the diatom index.

Materials and Methods

Study area

Um El-Naaj Marshes, one of the Iraqi marshes, which is located in Kahala district, and has two wiled entryways, through AL Kahla district - in the direction of Bani Hashem – Um El-Naaj Marshes, and another entrance is Kahla – Al mueel-Abo Khasaf village. Um El-Naaj Marshes Up to25 km in width and 30km depth to the Iranian borders. He was part of the partially dried marshes, then returned to him naturally after the fall of Saddam Hussein's regime to flood a large area of it, but still there are dried lands. Currently, this marsh is fed and revitalized with water through its outlets from inside Iraq like Alekhala River, AL Mshrah River and outside of Iraqi like Aldwiridj and Karkheh, Nissan and Alkfagia (Taylor *et al.,* 2011; Hassan *et al.,* 2012). Six sites were selected in Hor Al Huweiza, Um El-Naaj Marshes as shown in figure 1; identified by GPS as in Table 1. The study was conducted for six months, from November 2018-April 2019. For qualitative study; weigh 10g of host plants and cut into small parts 2-3 cm and shaking with 50-100 mL of environment water then scrapped surface plant by smooth brusher or the blade isn't sharp then preserved samples in containers plastic with 1mL of Lugol's solution. While quantitive study includes after separate diatom from plant putting the sample in cylinders (100 mL) for 10-15 days with 1ml of Lugol's solution for precipitation, then take precipitate (20-30mL) and stored in containers with some drops of Lugol's solution (Werner, 1977; Al Hassany and Al- Bueajee, 2015; Salman *et al.,* 2017). Marked containers sample with the date and site collection. For identification epiphytic diatoms preparing permanent slides examination under the microscope. The identification of diatoms done by using the following references (Patrick, 1966; Werner, 1977; Hadi, 1984).

Table 1. The geographical position of the study sites.

Sites	The coordinates	
	Longitude (eastwards)	Latitudes (northwards)
ST1	47°36′117"	31°37′022"
ST2	47°38′767"	37°38′409"
ST3	47°38′662"	31°38′028"
ST4	47°34′824"	31°37′143"
ST5	47°39′272"	31°37′370"
ST6	47°40′79"	31°36′887"

Trophic Indices

Diatomic index (Id) was calculated according to Descy's list (Descy, 1979) which consists of 155 species by using the following formula:

$$575<= \Sigma Aj \times Ij \times Vj / Aj \times Vj$$

Aj: is the relative abundance of the species j present in the sample.

Table 2. The values of diatom index and their interpretation.

Value of diatom index	Interpretation values
4.5	Best biological quality, no pollution
4-4.5	Almost normal quality (Slight changes in the community, slight pollution)
3-4	More important changes in the community, decreases of the sensitive species, moderate pollution or significant eutrophication
2-3	Resistant species dominant, decreases or disappearance of the sensitive species (reduced diversity), high pollution
1-2	Marked dominance of a few resistant species (many species disappear), very high pollution

Ij: the sensitivity index of the species.

Vj its indicating value.

The value of the DI index calculated by this formula varies from 1 to 5. For a simplified interpretation of the result, the following quality classes may be adopted in Table 2:

Trophic diatom index (TDI): Trophic diatom index was dependent on 155 diatom taxa chosen for their indicator value (tolerance to inorganic nutrients) and identification easily (Kelly and Whitton, 1995). This index was calculated by the following equation and the values for TDI in Table 3.

Table 3. The values for TDI ranged from 0-100.

Pollution Degree	Index value
Oligotrophic state	TDI < 35
Oligo-mesotrophic State	TDI 35-50
Mesotrophic State	TDI 50-60
Eutrophic State	TDI 60-75
Hypertrophic State	TDI > 75

$$TDI = \Sigma(AjS\ jVj/AjVj\ X25) - 25$$

Aj=the abundance or proportion of species j in sample

Sj= nutrient sensitivity of species j in the sample (1-5) values range from 1 for sites with very low nutrient concentrations to 5 for sites with very high nutrient concentrations

Vj= indicating value (1-3)

Generic Diatom Index (GDI): This index explained by the equation (Lecointe *et al.,* 2003), as following and the values for GDI in Table 4:

$$5:575<=(\Sigma AjS\ jVjAjVj) \times 4$$

Aj = abundance or proportion of species in the sample.

Sj = sensitivity species for nutrients (1-5)

Vj = the value of index (1-3).

Table 4. The values of Generic Diatom Index (GDI)

Water Quality	Value of (GDI)
High	17.5- 20
Good	14 -17.5
Moderate	10.5 -14
Poor	7 -10.5
Bad	< 7

Results and Discussion

The current study showed the trophic algae (TDI) in the Table 5. The highest value was 66.48 in December at site 5 while the lowest value was 37.76 in December at site 6.

These results of (TDI) represent the quality water of AL Hawaiza marshes which ranged from me-

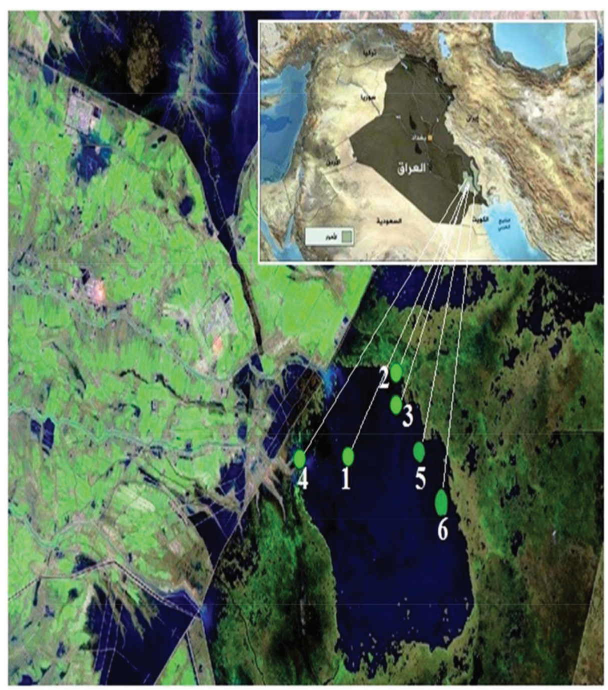

Fig. 1. Hor Al Huweiza, Um El-Naaj Marshes

sotrophic to eutrophic status (Al-Hassany, 2010; Shaawiat and Hassan, 2017). The increase of the nutrients in December was due to the increase in the activity of bacteria that analyze the organic substances in the water and thus work to increase the growth of algae (Sultana *et al.,* 2004; Al-Hassany, 2010; Köbbing *et al.,* 2013). Diatoms are commonly used as a bioindicator for evaluating especially freshwater quality, their use in the biological assessment of rivers in Iraq. Trophic diatom index (TDI) provided information about the state of the aquatic ecosystem. (Shaawiat, 2016; Shaawiat and Hassan, 2017). While A previous study showed the Tigris River is of a trophic level ranging from oligotrophic to mesotrophic, In contrast, the water quality ranges from medium to good water quality by Al Hassany and Al Bayaty, (2017) and Solak *et al.,* (2012) where the values are lower than that of a Porsuk Stream in Turkey which ranged between (121-139).

The Table 6 represents the rates of values of the Generic Diatoms Index (GDI); The highest value was in November (14.33) and December (14.63) in site 4,5 respectively; while the drop in January (7.48) and February (11.16) in site 1; and the raised again in April and March. Water ranges from good to moderates compared to the results obtained by us with the ideal values for this directory, you specify (Hungary Ministry of Environment and Water, 2005). The values obtained are that water quality ranges between good to moderate, the higher the values of GDI indicator the water quality tends to the water is good or, pollution is low and is suitable for living organisms as well also the nutrients in water are low (Hungary Ministry of Environment and Water, 2005; Shaawiat, 2016).

Table 7 showed the rates of values of the Diatoms Index; the highest value ranged between 3.3-3.5 in all sites under study in months November, March, and April, while three sites (1,2,3, and 5) in December, but just one site (3) in January and February. The lowest value was 2.51 in December at the site (6), this changes more important for the community, decreases of the sensitive species, moderate pollution or significant eutrophication, resistant species

Table 5. Variation of trophic diatom index of diatoms in the six sites(TDI)

TDI	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
ST1	61.6	52.9	43.4	44.81	64.53	61.55
ST2	57.61	55.57	44.63	45.14	62.28	56.51
ST3	59.11	54.11	54.77	54.53	61.31	61.03
ST4	64.62	48.91	47.11	45.95	60.77	61.16
ST5	59.79	66.48	47.84	47.95	59.32	56.75
ST6	64.08	37.76	47.13	44.85	58.02	54.25

Table 6. Variation of Generic Diatom index of diatoms(GDI)

GDI	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
ST1	13.87	12.46	7.48	11.16	14.32	13.84
ST2	13.21	12.89	11.12	11.22	14.96	13.04
ST3	13.45	12.65	12.76	12.72	13.8	13.76
ST4	14.33	11.95	11.52	11.27	13.72	13.78
ST5	13.56	14.63	11.64	11.67	13.48	13.08
ST6	14.25	10.04	11.52	11.24	13.28	12.67

Table 7. Variation of Diatomic Index of diatoms in the six sites(DI)

DI	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
ST1	3.46	3.11	2.73	2.97	3.58	3.46
ST2	3.3	3.22	2.78	2.8	3.49	3.26
ST3	3.36	3.16	3.19	3.18	3.45	3.44
ST4	3.58	2.98	2.88	2.81	3.43	3.44
ST5	3.39	3.65	2.91	2.91	3.37	3.27
ST6	3.56	2.51	2.88	2.79	3.32	3.17

Table 8. The number of epiphytic diatoms species attached to the host aquatic plants(*Phragmites australis*)and their percentage (according to their families)

Family taxa	Nov.		Dec.		Jan.		Feb.		Mar.		Apr.	
	No. sp.	%	No. sp.	%	No. sp.	%	No. sp.	%	No. sp.	%	No. sp.	%
Coscinodiscaceae	2	3.6	2	3	1	2.3	2	3.7	2	3.1	3	4.6
Achnanthidiaceae	3	5.4	3	4.6	5	11.6	6	11.3	8	12.3	8	12.3
Bacillariaceae	8	14.5	11	17	7	16.2	8	15.1	11	16.9	11	16.9
Catenulaceae	1	2	4	6.1	1	2.3	1	1.8	2	3.1	2	3.1
Cocconeidaceae	2	3.6	3	4.6	3	6.9	3	5.6	1	1.5	1	1.5
Cymbellaceae	3	5.4	7	10.7	2	4.6	2	3.7	6	9.2	6	9.2
Fragilariaceae	10	18.2	7	10.7	6	13.9	9	16.9	9	13.8	9	13.8
Gomphonemataceae	6	11	6	9.2	3	6.9	3	5.6	6	9.2	6	9.2
Naviculaceae	15	27.2	14	21.5	11	25.5	14	26.4	12	18.4	12	18.4
Rhoicospheniaceae	2	3.6	1	1.5	1	2.3	1	1.8	2	3.1	2	3.1
Rhopalodiaceae	2	3.6	1	1.5	2	4.6	2	3.7	2	3.1	2	3.1
Surirellaceae	0	0	0	0	1	2.3	1	1.8	3	4.6	3	4.6
Amphipleuraceae	1	2	6	9.2	0	0	1	1.8	1	1.5	0	0
Total	55		65		43		53		65		65	

dominant, decreases or disappearance of the sensitive species (reduced diversity), high pollution (Taylor *et al.*, 2005; Hassan and Shaawiat, 2016).

Table 8 Show families of diatoms (according to their species) different are attached to the host aquatic plants, Naviculaceae recorded 27.2 %, 21.5%, 25.5%, 26.4%, 18.4%,18.4% during the months of the study as more families available followed by Fragilariaceae that record 18.2, 10.7, 13.9, 16.9, 13.8, 13.8% respectively on *Typha domengensis* (host aquatic plant). These families were identified out of 154 taxa of epiphytic algae at seasons of study. This may be an indication of the abundance of plant nutrients or organic matter (Hassan and Shaawiat, 2016). The high diversity of some species in the Um El-Naaj Marshes may be due to the water quality in the river is suitable for high diversity due to the wide range of suitable growth conditions and when there is a difficult circumstance such as lack or increase of nutrients it reduces the presence of many species and gets a great chance for the growth of species that were originally present in a few natural conditions (De Jonge , 1990; Fo'ad, and Al-Zubaidi, 2012). The results show that temporal variations of epiphytic algae on aquatic macrophyta (*Phragmite saustralis*) depend on the morphology of host plant and seasonal water level variations. Factors, such as temperature, light intensity, turbidity, and nutrient plant are acting important roles as limiting factors for the distribution and density of epiphytic algae (Al Hassany and Al Bayaty, 2017). This study concluded Um El-Naaj Marshes has a high diversity of diatoms because water quality is suitable for the living of many species of organisms (Salman, and Hadi, 2015).

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