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Ecological study for diatoms in the Tigris River within Tikrit city, Iraq

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Abstract

An ecological study was conducted on diatoms in the Tigris River of Al-Balaj area in Tikrit city, from October 2018 to May 2019. The present study included measuring some physical and chemical characteristics of water, as well as qualitative study of diatoms, the results of current study showed that : Air and water temperature ranged from (10-34)°C and (10-25)°C respectively, Turbidity (10-50) NTU, TDS ranged from (824-1600) mg. l^{-1}, pH ranged 6.3-8.5, DO ranged between (1.5-3.2) mg. l^{-1}, Hardness ranged (124-270) mg. l^{-1}, Silica ranged between (1.47-2.53) mg. l^{-1}, phosphate (23.19-24.83) µg. l^{-1}, and NO_3 ranged from 5.61 to 11.42 µg. l^{-1}. Diagnosed of diatom was 51 species belonging to 18 genera were recorded. The dominant genera during the study period were: *Cyclotella,Melosira ,Achnathes , Cocconeis , Synedra , Fragilaria ,Navicula ,Gyrosigma ,Surirella ,Cymatopleura ,Amphora ,Gomphonema ,Cymbella Aulacoseira ,Cosinodiscus.* It reflects the water's quality and determines the extent and type of pollution.

Introduction:

Phytoplankton including diatoms, play a significant role in the food chain in water ecosystems due to their process of photosynthesis. Algae are regarded as the primary producers in the aquatic ecosystems [1,2]. Their abundance is influenced by environmental elements such as water depth, seasonal variations, light intensity, and the availability of zooplankton [3].

Diatoms have been chosen as diagnostic instruments for freshwater resources due to their successfully applied in various countries and different water bodies [4]. They have been used as indicators of environmental conditions, including organic pollution in rivers and ponds. Being widespread microorganisms, they are sensitive to various environmental factors, including light, temperature, flow rate, dissolved oxygen concentration, and pH. They are also excellent markers of nutritional enrichment, organic contamination, and climatic change [5].

Numerous investigations have been carried out concerning the diatom in the Tigris River [6, 7, 8, 9, 10, 11]. The aim of this study identifying the dominant of algae species and percentages their species within the study areas.

Material and Methods

Study area

The study was conducted in the area located on the right bank of the Tigris River, approximately 180 kilometers north of Baghdad and 330 kilometers south of Mosul. Salah Al-Din province is situated at a longitude between 43.35° E and 34.27° N. Tikrit city serves as the center of the province, Al-Balaj region is located in the city's center, it's the study site at a longitude between 43.42° .36 E and 34.38° .11 N (Fig.1), close to the river, and acts as the province's geographic center. In addition to its geographic location and agricultural area, this station was chosen for the study because it is close to the Tigris River and there is little available information about it.

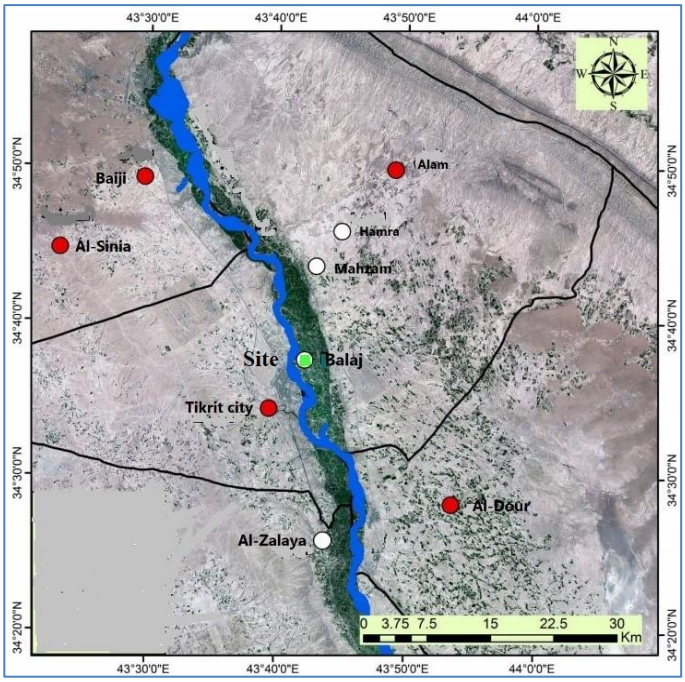

Fig. 1 Map of the study site in the Tigris River of Tikrit city

Sample collection

Samples water was collected monthly from the Tigris River of the Balaj site, in the morning from October 2018 to May 2019. Chemical and physical analyses of water as described by APHA [12] (Table 1). diatom samples collected for the qualitative study by phytoplankton net (mesh 20µm), the samples are in polyethylene containers, and preserved by Lugol's iodine solution [13]. The diatoms were identified using the following references [14, 15, 16, 17, 18], and their classification was based on Algaebase 2020 website.

Table .1 Standard methods for laboratory measurements

No.	Factors	Devices or Tools	Reference
1	Air Temperature (C°)	Mercuric Thermometer	---
2	Water Temperature (C°)	Mercuric Thermometer	---
3	Turbidity NTU	Turbidity meter	[12]
4	Total Dissolved Solids TDS mg. l^{-1}	Conductivity Multi meter	[12]

5	Dissolved oxygen (DO) mg. l^{-1}	Method Winkler Azide Modification	[12]
6	Total Hardness mg $CaCO_3 l^{-1}$	Titration with Na_2EDTA	[12]
7	Reactive Silicate mg. l^{-1}	Spectrophotometer (810 nm)	[12]
8	Reactive Nitrate µg. l^{-1}	Cadmium Reduction method	[12]
9	Reactive Phosphate µ. l^{-1}	Ascorbic Acid method	[12]

Statistical Analysis

The Statistical Package for the Social Science SPSS 20.0 program was used to analyze the results ($P \leq 0.05$).

Results and Discussion

The results showed that the air and water temperature ranged (10-34) Ċ and (10-25) Ċ respectively (Table 2). These results were consistent with [19], and [20].

Table. 2 Physical and chemical characteristics values (mean ± Standard deviation) of the Tigris River

Ecological Factors	Values
Air Temperature (C°)	10 – 34 21.12 ± 8.09
Water Temperature (C°)	10 – 25 16.25 ± 4.81
pH	6.3 – 8.5 7.71 ± 0.710
Turbidity (NTU)	10 – 50 28.78 ± 14.27
Total dissolved Solids (TDS) mg. l^{-1}	824-1600 1102.8 ± **42.11**
pH	6.3-8.5 7.71 ± 0.397
Dissolved Oxygen (DO) mg. l^{-1}	1.5 – 3.2 1.97 ± 0.62
T.H mg. l^{-1}	124 – 230 202 ± 41.30
Silica (SiO_2) mg. l^{-1}	1.472 – 2.538 2.41 ± 0.502
Phosphate (PO_4) µg. l^{-1}	23.199 – 24.837 24.01 ± 0.650
Nitrate (NO_3) µg. l^{-1}	24.03 – 29.32 25.93 ± 1.77

Turbidity value was recorded (10-45) NTU in May and February 2019 respectively. These results were higher than [20]. However, they were significantly lower than the results obtained by [8], [21], [22] and [23].

The increase in turbidity during the later months of the study period may be attributed to the rise in water levels, leading to the exposure of rocks, soil weathering, and dead plant parts, which lead to reduction in light penetration through the water column. As well as, wastewater discharge and industrial waste directly into the river, as well as agricultural activities [24].

TDS values ranged between (824-1600) mg. l^{-1} in May 2019 and October 2018 respectively, the increase of TDS concentration may be to anthropogenic industrial and domestic waste, evaporation processes.

pH is considered an indicator of the balance between acidity and alkalinity in water, and it is the dominant factor influencing most reactions and transformations that occur in water [25]. The results ranged from 6.3 to 8.5 in October 2018 and January 2019 respectively. The Tigris River is neutral to slightly alkaline in pH [26].

DO value was recorded (1.5-3.2) mg. l^{-1} in January 2019 and May 2019. Its important role in assessing water quality for aquatic life [27]. These results lower than [8], [20], and [28], [23].

Low oxygen levels in the river due to pollutants or water temperature, which has an inverse relationship with dissolved oxygen.

Total hardness concentration ranged between (124-270) mg. l^{-1} May 2019 and April 2019, the variation of hardness values may be to the decrease in water levels during the summer season and the evaporation that occurs in water bodies, which an increase in salinity and hardness.

The results showed Silica concentrations ranged (1.472 - 3.392) µg. l^{-1} in May 2019 and December2018 respectively. The silica found in this study may be due to the increased water flow and erosion brought on by rising water levels, which causes silica to rise to the water's surface [29]. The seasonal variation of silica salts is related to the diatoms' flowering period, which is incorporated in the structure's composition in a certain ratio [30]. It is one of the important factors that influence how aquatic organisms' development, particularly diatoms, However, compared to other nutrients, its availability in the aquatic environment is lower.

Nitrates are an important element in determining the growth of phytoplankton, and NO_3 concentration was recorded (6.95-11.42) µg. l^{-1}, while PO_4 ranged from 23.199 to 24.837 µg. l^{-1}, these results higher than [8], [20], [28], [31], and [23]. In general, the Balaj area has shown a noticeable increase in plant nutrients due to its status as a tourist destination where people spend their summers and engage in recreational activities throughout the year, leading to an increase in organic, industrial, domestic, and urban waste discharged into the Tigris River.

Human activities in the Balaj area contribute to increased microbial activity and oxidation of organic matter, resulting in the continuous mixing of sediments due to the influence of currents, leading to the proliferation of phytoplankton biomass and increased primary productivity. Additionally, the upward flow of cold deep water plays a role in bringing nutrients from the depths to the surface waters of the water column [32].

Note that the conditions of the river were unstable during the winter and spring seasons, which had an impact on the ecosystem's biological and chemical conditions. Diatoms are influenced by a number of important aspects, including the riverbed's features and the speed of the water. Ali *et al.* [2] mentioned that small local fluctuations in the current between the riverbanks and the middle of the river are thought to have a greater impact on the aquatic environment. In comparison to other aquatic habitats, flowing rivers typically have higher densities of algae [33].

The current study revealed the dominance of certain diatom orders throughout the study period. This study identified 51 diatom species belonging to 18 genera and 11 orders were found in the Balaj site (Table 3, Fig.2). The order Fragilariales was the most dominant, accounting for 25.4% of the total, *Synedra* and *Fragilaria* were its two most frequent genera as shown in Table 3.

The order Bacillariales followed with a percentage of 17.6%, including the genera *Pleurosigma*, *Nitzschia* and *Diatoma*. The order Aulacoseirales accounted for 15.6% with the predominant genus *Aulacoseira*. Surirellales represented 9.8% with well-known genera such as *Cymatopleura solea* and *Surirella* spp. The order Centrales accounted for 7.8%, with the important genus *Cyclotella*. The order Naviculales represented 5.8% and included the genera *Navicula.* and *Gyrosigma*. Achnanthales, Coscinodiscales, Cymbellales, and Melosirales, recorded 3.9%. *Gomphonema, Achnanthes, Melosiria varains, Cymbella aspera, Coscinodiscus* and *Cocconeis placentula* were the dominating genera in these orders. Lastly, the order Thalassiophysales which made up 1.9% of the total, the genus *Amphora* was being the predominant one.

Table .3 Diatoms and their proportions in the Tigris River at the study site

Bacillariophyta	No. of diatom species	%	Orders and genera	Dimensions of genera
Achnanthales	2	3.9	Achnanthales	10-20 mm long Less than 5mm wide
			Cocconeis	15-98 mm long 4-40 mm wide
Aulaciserales	8	15.6	*Aulacoseira*	4-20 mm diameter
Centrales	4	7.8	*Cyclotella*	5-30 mm diameter
Coscinodiscales	2	3.9	*Coscinodiscus*	*30-500um diameter*
Cymbellales	2	3.9	*Cymbella*	20-22 mm long 7-32 mm wide
			Gomphonema	8-120 mm long 3.5-17 mm wide
Fragilariales	13	25.4	*Fragilaria*	10-170 mm long 2-5 mm wide
			Synedra	60-400 mm long 5-9 mm wide
Naviculales	3	5.8	Naviculales	6-42mm long 4-12 mm wide
			Gyrosigma	60-400 mm long 11-40 mm wide
Bacillariales	9	17.6	*Nitzschia*	5-100 mm long 2.5-12 mm wide
			Diatoma	8-75 mm long 7-18 mm wide
			Pleurosigma	150-380 mm long 20-30 mm wide
Melosirales	2	3.9	*Melosira*	8-40 mm in diameter
Surirellales	5	9.8	*Surirella*	16-120 mm long 12-45 mm wide
			Cymatopleura	30-300 mm long 10-90 mm wide
Thalassiophyscales	1	1.9	*Amphora*	80-14 mm long 7-10 mm wide

Algae are among the fastest-growing plant floaters in river populations. Their response to environmental changes is evident, and the quantity of plant floaters can double daily during blooms and the availability of plant nutrients. Diatoms, in particular, are the most affected by nutrient availability, forming large colonies of billions of cells until the plant nutrients become scarce [19].

When diatoms are exposed to increased nutrients during favorable growth conditions, typically in spring, they take advantage of their maximum reproduction rates. These rates vary from one species to another, with the fastest-growing species dominating first.

As a result, diversity decreases, and one or some of these species become dominant. In some cases, a single species dominates a bloom, referred to as single species blooms. Nutrient depletion by diatoms is the prevailing process during bloom development, and water temperature plays a significant role in this context [18].

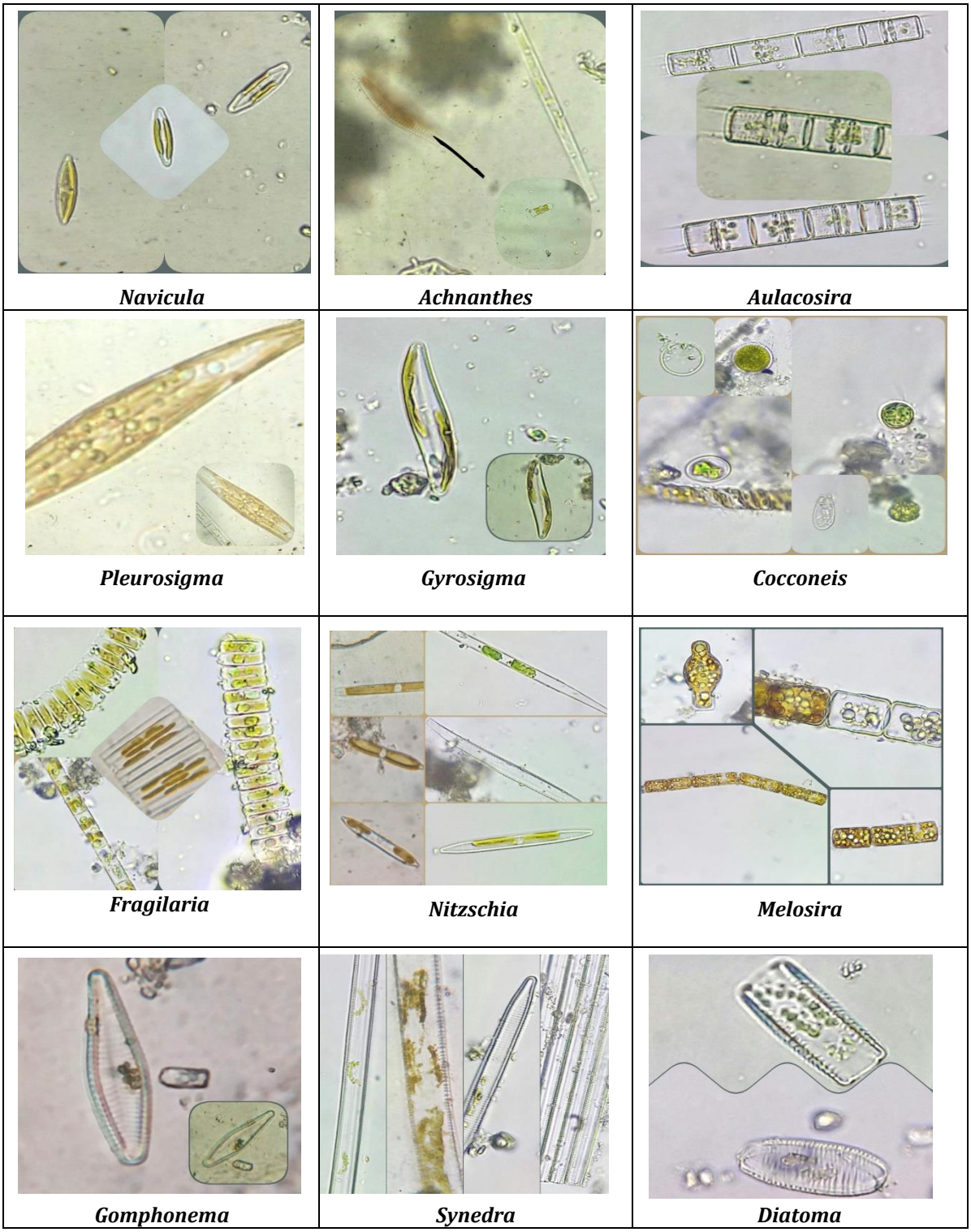

Fig.2 Photomicrographs of *Diatom* genera recorded in the study area of Tigris River by Binocular Microscopes (BioBlue) (40X)

Conclusions

This study demonstrated the physical and chemical characteristics impact and various environmental conditions on diatom distribution and spread. Additionally, it may be seasonal changes in water levels played significant roles as limiting factors for the distribution and density of phytoplankton diatoms, it may be indexing the water quality of the Tigris River.

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دراسة بيئية للدياتومات في نهر دجلة ضمن مدينة تكريت، العراق

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معلومات المؤلف
الايميل:
الموبايل:

الخلاصة:
أجريت دراسة بيئية على الدياتومات في نهر دجلة في منطقة البلاج في مدينة تكريت خلال الفترة من تشرين الأول 2018 إلى أيار 2019. وتضمنت الدراسة الحالية قياس بعض الخصائص الفيزيائية والكيميائية للمياه، فضلا عن الدراسة النوعية للدياتومات، وكانت النتائج أظهرت الدراسة الحالية أن: درجة حرارة الهواء والماء تراوحت بين (10-34) م° و(10-25) م° على التوالي، والعكورة NTU (10-50) ، وتراوحت المواد الصلبة الذائبة TDS من (824-1600) ملغم. لتر$^{-1}$، تراوحت الاس الهيدروجيني بين 6.3-8.5، وتراوحت الاوكسجين الذائب بين (1.5-3.2) ملغم. لتر$^{-1}$ صلادة تتراوح بين (124-270) ملغم. لتر$^{-1}$ تراوحت نسبة السليكا بين (1.47-2.53) ملغم. لتر$^{-1}$ فوسفات (23.19-24.83) ميكروغرام. لتر$^{-1}$، وتراوحت نسبة النترات من 5.61 إلى 11.42 ميكروغرام. لتر$^{-1}$. تم تشخيص الدايتومات وتسجيل 51 نوعاً تنتمي إلى 18 جنساً،: