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Diversity Measurement Indices of Diatom Communities in the Tigris River within Wasit Province, Iraq

Shaimaa F. Ali [1] ***Reidh A. Abdul-Jabar*** [1] ***F. M. Hassan*** [2*]

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Abstract:

The study was conducted to measure diatom species diversity in the lotic ecosystem across the Wasit Province for 12 months. The quantitative study of diatoms (phytoplankton) was investigated in the Tigris river. The density of algae was ranged from 60989 cell×10^3/l to 112780.82 cell×10^3/l in the five sites. These algae were belonging to 39 genera. The richness index values ranged from 1.53 at site 5 in January 2016 to 6.34 at site 1 and June2015. Shannon-Weiner diversity index (H′) was 2.33 in February 2016 and 3.72 in June 2015 both values at site 3, whereas Evenness index was 0.54 at site 5 in March2016 and 0.98 at site 1 in both August2015 and May2016. The lack of homogeneity of the appearance of species indicates the dominance of a few species with high densities, which is an indicator of the existence of environmental pressure. All studied indices showed that the Tigris River quality is suitable for the living aquatic life or may be slightly affected by the pollutants.

Keywords: Water quality, Diatoms, Tigris River, richness index, Shannon-Weiner index, Evenness index

Introduction:

The freshwater aquatic systems are the important sources the life of most aquatic organisms in inland water environment (1). The alteration in water quality and biodiversity in the lotic ecosystems caused by pollution, these alterations were lead to change the living strategy of organism and only the tolerant species were remains in this environment (2). Some algae such as diatom group use due to their ability to tolerate the cleaning in the enivronment (3, 4). Due to their life characterized such as rapid reproduction and short generation times these organisms considered as a good bioindicators and an alarm agent in aquatic ecosystems and their ability to respond to the alteration in the environment (5, 6). Hassan and Shaawiat (7) used phytoplankton as bio-indicators in Euphrates river, their study found 11 diatomic algae sensitive and 7 species tolerant to pollution species. Hassan and Shaawiat (8) applied 15 indices to evaluate the water quality of the Euphrates River.

[1]Department of Biology, College of Science, Tikrit University, Tikrit, Iraq.
[2]Department of Biology, College of Science for Women, University of Baghdad, Baghdad, Iraq.
[*]Corresponding authors:fikrat@csw.uobaghdad.edu.iq

This study aimed to apply the diversity indices of diatomic algae in water quality assessment in addition to studying the diatomic communities in this segment of the Tigris river.

Materials and Methods:

The Tigris River within the Wasit Province was selected for application diversity indices. Monthly sampling was taken from five sites along the Tigris River during the period from June 2015 to May 2016, 2014 (Fig. 1). The selected sites for this study were about 180 km from Baghdad city in the Wasit Province. This area is characterized by different an agricultural activity and to control the water discharge in this area a big dam constructed (Kut dam) for irrigation and power production purpose (9). For this study, five sites were selected along the river in this region (Figure1, Table 1).

The algal samples were preserved by Lugol's iodine solution, and concentrated nitric acid and the methods were used to clarify diatom frustule (10, 11). The following references were used to identify the algae (12, 13, 14, 15, 16, 17). Richness index was calculated according to Stiling (18), and the value of Shannon and Weaver and Evenness indices were calculated as follows (19).

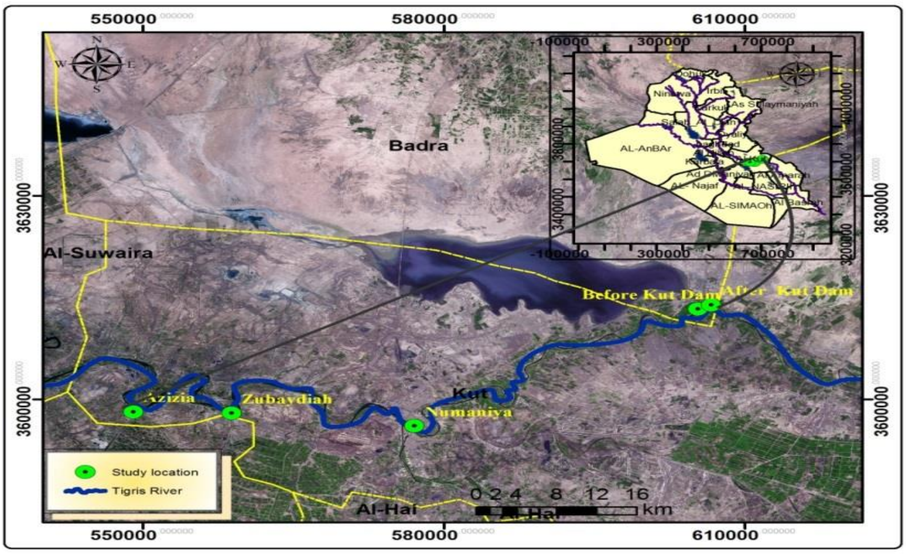

Figure 1. Map of study areas (Used Arc-GIS Map program)

Table 1. The geographical positions (GPS) of the five study sites.

Sites	Longitude (eastwards)	Latitudes (northward)
1	°.9818′35	54°.9050′
2	35°.9799′	55°.8840′
3	35°.9611′	57°.7080′
4	36°.1336′	60°.5320′
5	36°.1395′	60°.6604′

Results and Discussions:

The total number of algae ranged from (5082.41 cells × 10^3 /l at site5 to 9395.88 cells × 10^3 /l at site1. The centric diatom ranged (590.38 - 2045.52) cell × 10^3/l at the sites3 and 1, respectively. The pinnate diatom recorded the lowest value (4255.35 cell × 10^3/l) at site5, and the highest rate (7350.36 cells × 10^3 /l) at site1 (Table 2). The total number of species and genera were ranged 159-179 and 38-39, rspectively (Table 2). The results in the present study showed the total number of diatoms is higher than that recorded by Al-Janabi (20).The increase in the total number of phytoplankton recorded in the present study on the Tigris River may be due to increased nutrient concentrations in these sites where they are exposed to additions of agricultural land and household waste from residential areas near the river (21, 22). The low number recorded may be due to the lack of nutrient concentrations due to the reduction in water levels and the increase in flow velocity in the river, which prevents the growth of phytoplankton well as it moves quickly to areas other than is suitable for its growth and reproduction (23), and may be due to the lack of light permeability due to increase the turbidity from the speed of flow in the river, which works to move the bottom sediments and return to the water column, which is the turbidity caused lack of sufficient light access to the phytoplankton spread in the water column (24).Also the increase and decrease in the numbers of diatoms may also be attributed to the disruption of water levels in the river (25), which may lead to the re-attachment of some benthic species in the water column (26). The relationship between river drainage and living mass is inversed (27).

The richness index ranged from 1.53 at site5 in January 2016 to 6.34 at site1 in June2015 (Table3). Significant temporal and spatial differences ($P \leq 0.05$) were noticed. When comparing these values with the standard values, the higher the values indicate the high diversity of diatoms in the Tigris River, indicating that the diversity in the Tigris River is high, may be due to variation in the values of the index to increase algae during the period Study or lack of pollution and lack of grazing by zooplankton for algae (28). Species abundance is the number of taxonomic units diagnosed and represents diversity within the sample. This indicator is defined as the absolute number of taxonomic units in a biomass at a location within the water surface. This indicator uses a key to other measurements, which consists of taxonomic units classified to the species level, so that the abundance of species reflects the diversity of water groupings (29).

The Shannon diversity index (H′) varied between the lowest value (2.33) at site 3 in February 2016 and the highest value (3.72) at site3 in June2015 (Table 3). A significant differences ($P \leq 0.05$) of noticed among seasons and sites.

The results revealed that the Shannon index values were more than 1. These results indicated a high diversity in the study area and the non-dominance of certain types of phytoplankton, while the few values (less than1) indicate the dominance of certain species of phytoplankton on the appropriateness of environmental conditions from physical and chemical factors in the study sites that assist in the growth and diversity (30).

The results showed species similarity among sites. The differences recorded for the species in the sites may be due to the nature of the site, in the nature of the land in which the river passes and the residential areas and the specifications of the site itself in terms of the presence of curvature and the presence of some drainages in which it flows (31). The spread of aquatic plants has been helped, to the adherence algae on these plants, as well as nutrients and other factors. (32).The water of the Tigris River in the present study, based on this index, it is found that water quality ranges from moderate polluted to clean water.

The Evenness index values ranged from 0.54 at site5 in March2016 to 0.98 at site1in August2015 and May2016 (Table 3). The significant differences were noticed among seasons and sites ($P \leq 0.05$). Higher values of the species of Evenness index in the river indicate that there is no stress or environmental pressure on the diatomic species in the rivers, where the values exceeded 0.5 in most seasons and months of the study so that the species are homogeneous in appearance(33). This is agreed with Green (34). Green (34) revealed that the lack of homogeneity of some algae existence indicated the dominancy of a few species with high densities and these considered an indicator of the existence of environmental pressure.

The difference in values may be due to the index of diatoms adhered to the runoff system that can cause a change in the depth and geology of the river's surface and surface, and may be due to the dominance of a particular species over other species (34). Different in the result values between sites and months to the nature of conditions that may be appropriate or inappropriate for the presence of diatoms (35).

Table 2. Biological characteristics of phytoplankton diatoms and biodiversity index in the Tigris River during the study period.

Parameters	Sites				
	S1	S2	S3	S4	S5
Total number of diatom algae (cell× $10^3/l$)	4146.8-15419.1 8362.317	2782.7-9321.4 5671.675	1705.3-8970.4 5333.758	1936.9-8592.6 4053.567	2978.9-8070 5082.417
Total number of Centrales diatoms (cell× $10^3/l$)	19.4-2932 2045.525	19.4-1096 813.06	19.4-1183 590.38	29.1-1388 727.825	9.7-1170 827.05
Total number of Pennales diatoms (cell× $10^3/l$)	9.7-2596 7350.36	9.7-1523 4922.24	9.7-1142 4772.53	9.7-1149.7 4664.38	9.7-388 4255.38
Total number of species	164	179	159	164	169
Total number of genera	38	39	38	39	39
Richness Index (D)	2.93-6.34 4.67	2.77-5.72 4.53	1.96-6.23 4.94	2.45-5.67 4.13	1.53-5.63 3.89
Shannon and Weaver Index (H)	2.96-3.59 3.22	2.62-3.54 3.15	2.33-3.72 3.19	2.62-3.68 3.07	2.62-3.46 2.91
Species Uniformity Index (Evenness) (E)	0.83-0.98 0.92	0.83-0.97 0.91	0.85-0.96 0.90	0.58-0.91 0.78	0.54-0.93 0.72

Table 3. Monthly averages of diversity indices of phytoplankton diatoms during the study period 2015-2016.

Sites	Factors \ Months	2015 June	2015 July	2015 August	2015 September	2015 October	2015 November	2015 December	2016 January	2016 February	2016 March	2016 April	2016 May
S1	Richness Index (D)	6.34	5.22	5.19	3.88	3.55	3.71	2.93	4.33	5.22	5.34	5.23	5.11
S2	Shannon and Weaver Index (H)	3.59	2.93	3.45	3.25	3.27	3.6	2.96	2.88	3.04	3.45	3.04	3.25
S3	Evenness Index (E)	0.95	0.93	0.98	0.94	0.93	0.92	0.91	0.87	0.83	0.91	0.93	0.98
S4	Richness Index (D)	5.42	4.67	5.72	3.46	4.28	3.83	2.77	4.31	5.25	4.74	5.21	4.78
S5	Shannon and Weaver Index (H)	3.54	2.77	3.12	3.29	3.29	3.45	3.12	2.62	3.23	2.76	3.21	3.45
S1	Evenness Index (E)	0.94	0.92	0.97	0.94	0.89	0.91	0.92	0.83	0.85	0.92	0.95	0.96
S2	Richness Index (D)	6.23	5.15	4.36	3.23	3.2	2.89	2.6	1.96	3.84	4.36	5.2	4.33
S3	Shannon and Weaver Index (H)	3.72	3.18	3.43	3.25	3.29	3.35	3.18	2.53	2.33	3.6	3.08	3.42
S4	Evenness Index (E)	0.94	0.86	0.96	0.92	0.89	0.85	0.93	0.91	0.85	0.89	0.96	0.92
S5	Richness Index (D)	5.67	5.2	4.33	4.03	3.19	2.72	2.57	2.45	5.03	4.74	5.2	4.46
S1	Shannon and Weaver Index (H)	3.68	2.62	3.24	3.21	2.87	3.45	3.18	2.82	2.66	2.62	3.24	3.31
S2	Evenness Index (E)	0.86	0.91	0.82	0.75	0.84	0.77	0.66	0.75	0.64	0.58	0.91	0.89
S3	Richness Index (D)	5.63	5.09	4.33	3.79	3.2	2.58	1.91	1.53	4.28	4.71	5.19	4.45
S4	Shannon and Weaver Index (H)	3.46	2.53	3.26	2.82	2.82	3.31	3.04	2.62	2.74	2.38	3.2	2.84
S5	Evenness Index (E)	0.64	0.84	0.73	0.66	0.82	0.75	0.72	0.66	0.64	0.54	0.93	0.82

Conclusions:

Both the indices of Richness index (D) species and Shannon and Weaver Index (H) showed that the Tigris River in the study sites has a high diversity of diatoms because water quality is suitable for the living aquatic life and is not or slightly affected by the pollutants that are released to it. This is confirmed by Evenness Index (E), which recorded high values and lack of species homogeneity with high densities, which is an indicator of environmental stress.

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Conflicts of Interest: None.

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قياس دلائل التنوع لمجتمع الدايتومات في نهر دجلة ضمن محافظة واسط، العراق

شيماء فاتح علي[1] **رياض عباس عبد الجبار[1]** **فكرت مجيد حسن[2]**

[1] قسم علوم الحياة، كلية العلوم ، جامعة تكريت، تكريت، العراق.
[2] قسم علوم الحياة، كلية العلوم للبنات، جامعة بغداد، بغداد، العراق.

الخلاصة :

تناولت الدراسة قياس تنوع انواع الدايتومات في نهر دجلة ضمن محافظة واسط من حزيران 2015 حتى أيار 2016. و الهدف من الدراسة تشخيص الدايتومات وتوزيعها الرئيسي في النهر من بيانات نهر دجلة التي تم جمعها من خلال الدراسة الكمية للهائمات النباتية الدايتومية. وقد تراوح العدد الكلي للهائمات النباتية الدايتومية في هذه الدراسة بين (60989 - 112780.82) خلية × 10^3 / لتر من العدد الكلي للهائمات النباتية الدايتومية في المواقع الخمسة والتي تنتمي إلى 39 جنساً. تراوحت قيم دليل الغنى من 1.53 في الموقع 5 في كانون الثاني 2016 الى 6.34 في الموقع 1 في حزيران 2015. وتراوح مؤشر تنوع شانون- وينر بين 32.33 و3.72في شهري شباط 2016 وحزيران 2015 كلاهما سجلت في الموقع 3، بينما دليل تجانس ظهور الانواع تراوحت بين 0.54 في موقع 5 اثناء شهر آذار 2016 و0.98 في المواقع1 اثناء شهري آب 2015 وأيار 2016. فقدان تجانس ظهور الانواع دليل على سيادة انواع قليلة مع كثافة عالية، وهذه دلالة على وجود الضغط البيئي واظهرت جميع المؤشرات المدروسة بان نوعية المياه في نهر دجلة مناسبة للاحياء المائية او قد تكون متاثرة بشكل طفيف بالملوثات.

الكلمات المفتاحية: نوعية المياه، الدايتومات، نهر دجلة، دليل الغنى، دليل شانون- وينر ، دليل تجانس.