Biodiversity of epipelic algae in the Baghdad Island tourist lake, Iraq.

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Abstract

The aim of the current study is to estimate the biodiversity of epipelic algae of the waters of the Baghdad Island tourist lake, where samples were collected monthly from three selected sites for the period from November 2021 to May 2022 and the results were expressed quarterly. A qualitative and quantitative study of epipelic algae was conducted, with tests for the physical and chemical factors of water. Three biodiversity indices ware studied: Shannon's index, Richness index, and Similarity index. There are 248 species belonging to 86 genera of epipelic algae. The highest total number of algae cells was recorded at 246.6 x 103 cells / cm2, while the lowest total number was recorded at 89.7 x 103 cells / cm2. The waters of the Baghdad Island tourist lake are considered to be of high biodiversity, medium rich in species, and similarity ratios are close between the sites and the current study seasons due to the small area of the lake.

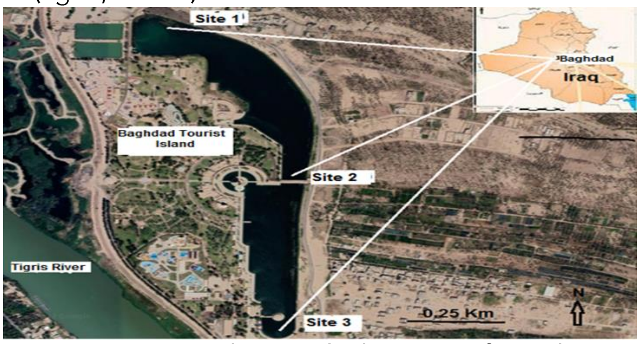
Keywords: Biodiversit Indices, Epipelic algae, Baghdad Island tourist lake

1. Introduction

Benthic algae refer to a group of algae associated with submerged aquatic environments. It is divided into types according to the type of medium in which it grows (Karthick & Ramachandra, 2009). Benthic algae are found at the bottom of the water column In lakes and rivers, and in direct association with sediments including rocks, mud and organic matter, these algae may form large growths that grow on inorganic surfaces or on organic debris. They are frequently found in mixed biofilms (with bacteria, fungi, and invertebrates also present). Under high light conditions, the thin biofilms may become the gathering place for the extensive growth of filamentous algae. Benthic algae can also be attached to organisms such as air plants - including higher plants, macroalgae, and colonies of macrophytoplankton. Some benthic algae are not permanently attached to surfaces but are able to move across the surfaces of the media on which they grow (such as Pennales diatoms), unsealed as they are held together with the gelatinous biofilms or are kept within the intertwined filaments of mature periphyton biofilms. Many species of algae may be benthic and benthic in their life cycle stages in some cases benthic algae develop and they become optically active, which later separate and become afloat in the aqueous medium. In other cases, algae spend most of their activity in the phototrophic stage as plankton in the aquatic medium but spend the winter as metabolically inactive as an inactive stage transforming into benthic algae. (Sigee, 2010 & Bellinger).

2. Material & Methods

The tourist island of Baghdad is located in the northern part of the city of Baghdad, 20 km away in the Al-Fahama area, which is characterized by agricultural areas consisting of a large group of palm groves and trees, It is one of the vital tourist facilities of the city of Baghdad, and is bordered on the right by the Tigris River. The lake is located on the right side of the island and has a total capacity of 370,000 m^3 and takes the shape of an elongated crescent. Its length is 1600 m, and its average width is about 125 m (fig. 1, Tab. 1)



Fiq. (1) A map showing the locations of sample collection. (Google Earth)

Tab. (1) the geographical coordinates of the sampling sites in the lake of Baghdad Island touristic (Google map)		
Geographical coordinates		Sites
Longitude (East)	Latitudes (North)	
33° 27' 00"	44° 20' 34"	Site 1
33° 26' 37"	44° 27' 00"	Site 2
33° 26' 13"	44° 20' 47"	Site 3

Samples were collected monthly for three sites selected within the lake water for the period from November 2021 to May 2022 and included water samples for physical and chemical tests and epipelic algae samples to conduct a qualitative and quantitative study and indices of biodiversity. A set

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of factors were conducted directly in the field, namely, air and water temperature, pH, electrical conductivity, total dissolved solids and turbidity according to Welch (1952). Nitrate, nitrite and sulfate according to APHA (2017), BOD according to Eaton et al., (2005), and phosphate according to Eisenreich et al., (1975) &Murphy & Riley (1962). Epipelic algae samples were collected according to Eaton and Moss (1966) method, its diagnosis was based on Patrick and Riemer (1966), Hinton & Maulood (1980) and Germain (1981). Three biodiversity indices of the Epipeli algae were conducted as shown in the table (2).

Tab. (2) Biodiversity indices and methods for calculating them.		
Indices	Calculate	Source
Richness Index	$(S-1)/\ln N$	Stiling 1996)
Shannon and Weaner Index	Σ Pi In Pi	Shannon (1949)
Jaccard's Similarity Index	$\frac{A}{B} \times 100$	Jacard (1912)

whereas

S = number of species in the sample.
N = total number of individuals in the sample.
Pi = Number of individual / Total number of samples >
A = number of species present in the first site and not found in the second site.
B= The number of species present in the second site and not present in the first site.

3. Result & Discussion

Physical & Chemical Parameters: According to Table (3), the waters of Lake Baghdad, the tourist island, are warm. It has a medium alkalinity , and the pH values recorded a slight variation in their rates, which confirms that the water of Baghdad Island Lake has a high buffer capacity due to the water containing carbonate and bicarbonate compounds as well as the erosion of the soils containing them as The Iraqi soil is rich in carbonate and bicarbonate compounds, and when it enters the water, it works to neutralize the acidity in the aquatic environment (Al-Safawi, 2007). The conductivity values exceeded the permissible limits, so the lake water is considered to have a high electrical conductivity. The highest recorded rate of total dissolved solids concentration / l, so the lake water has exceeded the permissible limits for this factor (CCME, 2007; WHO, 1998), and this may be due to the Tigris River feeding the lake, which leads to an increase in total dissolved solids as well as on human activities in the lake (Al-Hasso & Al-Tamimi, 2022). The turbidity values exceeded the permissible limits, this may be attributed to the activity and growth of aquatic organisms such as algae (Al-Fraidawi, 2018). Where the lake water did not exceed the permissible limits for the concentrations of the total hardness, and that its water is considered Hard to Very Hard, and this hardness is considered non-carbon due to the superiority of the total hardness over the total alkalinity values (Al Dulaimi, 2013). The lake water is well aerated, as the dissolved oxygen values exceeded 5 mg /l, and many factors contribute to the increase in dissolved oxygen in the water, including the activity of photosynthesis in the aquatic environment, low temperature, and the merging of atmospheric oxygen with water through air currents and winds (Wetzel, 2001). The biological oxygen Demand, it did not exceed 5 mg / liter, so the lake water is considered to be of moderate organic pollution (Al-Nimrawi, 2007). Nitrate values it was shown that they are available in the lake water, this may be attributed to the availability of dissolved oxygen, causing the oxidation of nitrite to nitrate, which is available in the water by the action of algae cells that carry out the process of Photosynthesis (Hassan, 2004). The nitrite values in the lake water are low, perhaps due to the lake water's high content of dissolved oxygen, which in turn leads to the oxidation of nitrites resulting from the processes of decomposition of organic matter into nitrates, (Peirce etal., 1998; Al-Lami etal., 1999.). Phosphate concentrations exceeded the permissible limits in the lake water, this may be due to the pollution in the Tigris River due to the dumping of untreated sewage water containing detergents, as well as agricultural fertilizer residues (Al -Tamimi & Al-Obeidi, 2021).

Table (3) The range (Up) and the mean standard deviation (Down) of the physical and chemical parameters in the sampling sites of the Baghdad Island tourist lake for the period from March to July 2022.

Site			Parameters
3	2	1	
20 – 3 30 ± 8.10	19 -37 26 ± 8.30	19 – 4 29 ± 8.6	Air Temperature (C°)
16.3 – 30.5 20.0 ± 7.10	15.6 – 31.3 20.0 ± 7.55	15.0 - 30.7 19.7 ± 7.36	Water Temperature (C°)
7.4 – 8.4 7.91 ± 0.5	7.3 – 8.3 7.77 ± 0.48	7.2 – 8.2 7.67 ± 0.38	pH
131 – 161 143 ± 12.6	101 – 171 136 ± 31.08	91 – 149 125 ± 24.6	Total Alkalinity (mg $CaCO_3$/ l)
756 -1684 1056 ± 428	755 -1351 964 ± 275	738 – 1086 932 ± 168	Electrical Conductivity (µ.s / cm)
371 – 1011 594 ± 291	373 – 1891 813 ± 722	363 – 652 487 ± 142	Total Dissolved Soled (mg/ l)
4.4 – 18.5 8.42 ± 6.9	2.4 – 8.9 6.35 ± 2.7	2.3 – 19.8 8.44 ± 7.6	Turbidity (NTU)
310 – 860 484 ±253	300 – 1116 541 ± 385	280 – 432 353 ± 66.5	Total Hardness (mg $CaCO_3$/l)
6.19 – 7.03 6.36 ± 0.36	6.09 – 7.05 6.53 ±0.53	6.23 – 6.79 6.53 ± 0.29	Dissolved Oxygen (mg / l) l
2.01 – 3.41 2.97 ± 0.65	3.08 – 3.62 3.29 ± 0.26	3.21 – 3.42 3.33 ± 0.10	Biological Oxygen Demand (mg / l)
2.0 – 10.1 6.05 ± 3.52	2.6 – 10.2 5.43 ± 3.49	2.3 – 10.1 6.05 ± 3.76	Nitrate (mg / l)
0.6 – 3.1 1.81 ± 1.07	0.6 – 2.2 1.34 ± 0.68	0.6 – 2.9 1.77 ± 3.99	Nitrite (mg / l)
0.1 – 5.05 2.74 ± 2.36	0.1 – 5.09 2.91 ± 2.55	0.1 – 5.09 3.48 ±2.33	Phosphate (mg / l)

Algal assemblages: There are 248 species in the current study belonging to 86 genera (fig.2, Tab.5). Where 55 species (22 %) were identified belonging to the Cyanophyceae belonging to 17 genera

(19.77%) and 42 species (17 %) were identified to the Chlorophyceae belonging to 27 genera (31.39%), in While he identified 8 species of the Centrales (3 %) belonging to 5 genera (5.81%), while the Pennales identified 129 species (51 %) belonging to 28 genera (32.55%). Limited numbers and small percentages were identified for the rest of the other classes, where 5 species (2 %) of the Dinophyceae were diagnosed, belonging to 4 genera (4.65%), while 3 species (1 %) of the Chrysophyceae belonging to the 2 genus (2.32%), and one species of Xanthophyceae belongs to one genus (0.4%), and one species of Rhodophyceae belongs to one genus (1.16%). As for Euglenophyceae, 5 species (2%) were identified, belonging to two genera (2.32%). The dominance of the numbers of epipelic diatoms species over the rest of the ranks of other algae, which is a case recorded in many studies in Iraqi waters (Hassan et al., 2020). The results showed that the feathered diatoms had higher percentages than the Centrales diatoms for the number of species and genera. This result was in agreement with previous studies of the waters of the Baghdad Island lake tourism (Ismail, 1989; Kazim, 2021; Obaid, 2021) due to the ability of diatoms to tolerate a wide range of Environmental changes from salinity, light intensity, temperature, and plant nutrient concentration to their ability to grow and reproduce in wide ranges of these environmental changes, and they respond quickly to biological, chemical and physical factors (Hassan et al., 2013).. The percentage of species numbers for a row of Cyanophyceae (55%) was recorded higher than the percentage of species numbers for a row of Chlorophyceae, which gives the impression that the lake water contains percentages of salts, and this was confirmed by the current study by exceeding the permissible limits of conductivity (Talling, 1980).

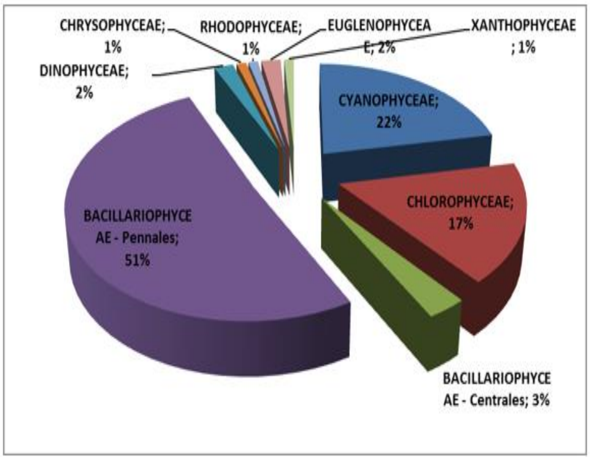

Fig. (2) Percentage of the numbers of identified species in sampling sites in the Baghdad Island tourist lake for the period from November 2021 to May 2022.

Table (4) indicates the numbers of species and genera of epipelic algae diagnosed in the current study according to the studied sites in the lake of Baghdad Island tourism, where site 1 recorded the largest number of diagnosed species, including 202 species belonging to 68 genera, the high number of species in this site is an indicator of diversity the high level is also an indicator of the presence of small percentages of pollution (Al-Hasoo & Al-Tamimi, 2022). The identified species in Site 3 are less than those identified in Site 1, which gives an impression of the impact of this site on human activities, as the site contains steamboats and the location of their maintenance, leaving oils and fuel waste in the site's water, which negatively affects the biodiversity of epipelic algae (Hassan) & Shaawiat, 2015).

Table (4) Numbers, spices and genera of epipelic algae according to their main gropes in the sampling sites in the Baghdad Island tourist lake for the period from November 2021 to May 2022.

Total		Euglenophyceae		Rhodophyceae		Xanthophyceae		Chrysophyceae		Dinophyceae		Bacillriophyceae (Pennales)		Bacillriophyceae (Centrales)		Chlorophyceae		Cyanophyceae		Taxa
G	Sp	G	Sp	G	Sp	G	Sp	G	Sp	G	Sp	G	Sp	G	Sp	G	Sp	G	Sp	
68	202	1	3	1	1	0	0	2	2	o	4	25	102	1	6	23	38	15	46	S.1
76	169	1	2	0	0	0	0	0	0	1	3	24	89	1	6	32	27	17	42	S.2
75	170	1	3	0	0	1	1	1	2	0	3	24	91	4	4	35	27	9	39	S.3
218	541	2	8	1	1	1	1	3	4	1	10	73	282	6	16	90	92	41	127	Tot

Table (5) Diversity and presence epipelic diatoms in study site in the Baghdad Island tourist lake for the period from November 2021 to May 2022.

Taxa	Site 1	Site 2	Site 3
CYANOPHYCEAE			
Anabaena affinis Lemmermann	++	++	++
Torulosa (Carm)Lagerheim	+	-	+
A.oscillarides Bory	++	+	++
A. wisconsinesnse Prsecott	-	-	+
Anabaena sp.	+	-	-
Aphanocapsa. endophytica	++	+	+
A. grevillei (Carm.) Rabenhorst	-	-	++
Aphanothece castagnei(Breb).Rabenhorst	+	-	-
A. microscopica Nägeli	+	-	+
A.stagnina (spreng) A.Braum	+	-	-
Calothrix parietana (Nag).Thuret	-	+	-
Chroococcus miutus (Keis.) Lemmermann	-	-	++
C. limneticus Lemmermann	+		++
C. turgidus (Kütz.) Nägeli	-	+	+

Coleospaerium dubium Grunow	+	+	-
C.kutzingiana Nageli	-	+	-
Gomphosphaeria aponina var. cordiformis Wolle	++	+	++
G. pallidum Chodat	+	-	++
Lyngbya aestuarii Lammermann	++	+	+
L. limntica Harvey	+	++	+
L.martensima Meneghinii	+	+	-
L. major (Meneghini)	-	-	++
Merismopedia elogan Nägeli	+	++	++
M. glauca Beck	++	+	++
M.tenuissima Lemmermann	+	+	+
Microcystis aeruginosa Kützing	++	+	++
M.flos-aquae(Wittr.)Kirchner	-	-	+
M.incerta Lemmermann	+	+	-
Nostoc lobatus Agardh	+	+	-
N.sphaericum Vaucher	+	-	-
Oscillatoria anguina (Bory)Gomont	+	+	+
O. amphibia Agardh	++	++	++
O. bornetii Zukal	-	+	+
O. chalybea Mertens	++	++	++
O. cumitata Gomont	-	-	++
O. curviceps (Kütz.) Gomont	++	+++	++
O. formosa Bory	++	++	++
O. limnetica Lemmermann	+	+	++
O. limosa (Roth.) Agardh	++	++	++
O.nigra Agardh	+	-	-
O.prolifica Vaucher	+	+	+
O. sancta (Ktz)Gomont	-	-	++
O.tenuis Skuja	+	-	-
Phormidium ambiguum Gomont	+	+	-
P. favesam (Bory)Gomont	+	++	++
p.tenue(Menegh)Gomont	+	+	+
Rivularia hansgirgii Schmidt	+	+	-
Spirulina laxa G.M.Smith	+	-	++
S. laxissima. Fo.major G. west	+	+	+
S. major Ktz	+	++	+
S. princeps west and West	+	-	++
Synechoccus major Schroeter	++	+	-
Tetradron pentaedricum West and west	+	-	-
CHLOROPHYCEAE			
Ankistrodesmus braunii (Corda) Ralfs	+	+	++
Aphanochaete repens A. Braun	-	-	+
Bulbochaete sp.	+	-	+
Characium ambiguum Hermann	-	-	+
C.ornithocephalum A. Braun	+	+	-
Chlorella vulgaris Bejerinck	+	+	++
Cladophora glomerata (L.) Kützing	-	-	++
Closterium dianae Ehrenberg	++	-	-
Coelastrum microporum Nägeli	++	-	++
Coelochaete scutata de Brebisson	+	-	-
Cosmarium contractum Meneghinii	+	+	++
C. laeve Rabenhorst	+	-	-
C. subgranatum (Nord.) Lutkem	++	+	++
C. subtumidium Nordstedt	+	++	-
Cosmocladium sp.	-	+	-
Drapanaldia judayi Prescott	+	-	-
Euastrum dubium Nägeli	++	++	+
Kirchnerella lunaris	+++	++	+
Microspora pachyderma (Wil.) Lagerheim	+	-	++
Mougeotia sp.	-	-	+
Oedogonium crassum (Hass.) Wittrock	+	++	++
O. sociale (Wittr.) Nordstedt	-	++	-
O. undulatum (de Bréb.) A. Braun	++	++	++
Oedogonium sp.	+	-	-
Oocystis crassa Wittr. & Nordstedt	++	++	++
O. elliptica W.West	++	-	++
Oocystis sp.	-	+	-
Pediastrum duplex (Turp.) Meneghinii	+	-	-
Pithophora varia Wille	++	-	++
Scenedesmus arcuatus Lemmermann	++	++	-
S. bijuga (Turp.) Lagerheim	++	++	+

S. dimorphus (Turp.) Kützing	++	++	+
S. ellipticus Wandg.mwest	+	-	-
S. quadricauda (Turp.) de Brébisson	+	+	+
Spirogyra scrobiculata (Stoch.) Czurda	-	+	-
S. nitida (Dil.) Link	-	-	++
Staurastrum gracile Ralfs	++	+	+
Stigeoclonium stagnatile (Haz.) Collins	++	-	-
Tetraedron minimum(A.Braum)Hansgirg	+	+	+
Ulothrix zonata (Weber et Moher) Kutzing	+	+	-
U. vaibilis (Kts) Kirchner	+	+	-
Westella linearis	+	+	+
BACILLARIOPHYCEAE			
CENTRALES			
Aulacoseira varians Agardh	+++	-	-
Coscinodiscus lacustris	+	+	-
Cyclotella meneghiniana Kützing	+++	++	++
C. ocellata Pantoccsek	+++	++	+++
C. stelligera Cl. U. Grunow	-	++	+++
C. striata (Kütz.) Grunow	+++	-	+++
Melosera varanis Agardh	++	+	-
(Her)Grun Stephanodusus astera	+	+	-
PENNALES			
Achnanthes affinis Grunow	+	++	+
A. gibberula Grunow	_	-	++
A. hungarica Grunow	+++	-	-
A. lanceolata de Brébission	++	-	++
A. lanceolata dubia Grnow	_	++	-
A. linearis W. Smith	+++	++	-
A. microcephala (Kütz.) Grunow	+++	++	++
Amphiprora alata Kützing	++	-	++
Amphora coffeaeformis Agardh	++	+	++
A. commutate Grunow	++	++	++
A. maxicana var. major Cleve	++	++	++
A. normanii (Rab)	++	-	++
A. ovalis Kützing	+	+	++
Bacillaria paradox.(Gmelin)	++	+++	-
B. paxillifer (Müll.) Hendy	+	+	++
Cymatopleura solea (Breb)W.smith	++	++	+
C. elliptica var.nobillis(Hantzsch)Hustedt	-	-	+
Caloneis bacillum (Grun.) Mereschkowsky	+++	+	++
C. ventricosa(Her).Mrister	++	++	-
Cocconeis pediculus Ehrenberg	++	++	++
C. placentula Ehrenberg	++	++	-
C. placentula var. euglypta (Ehr.) Cleve	++	++	-
C. placentula var. lineata (Ehr.) Cleve	++	+	+
Cymbella affinis Kützing	+	++	+
C. aspera (Ehr.) Cleve	++	-	-
C. cistula (Hemp.) Grunow	+	++	++
C. microcephala Grunow	+	++	++
C. pusilla Grunow	-	-	+
C. tumida (Bréb.) V. Heurck	+++	++	++
C. turgida (Greg.) Cleve	+	+	+
C. ventricosa Kützing	++	++	-
Diatoma vulgare Bory	+++	-	++
D. elongatum var. minor Grum	+	-	-
D. hiemale(Roth)Heibery	-	+	++
Diploneis ovalis (Hisle) Cleve	-	+	+
Epithemia sorex Kützing	-	+	+
E. turgidus var.granulata (Ehr.) Grunow	+	-	+
Eunotia formica Ehrenberg	-	+	+
E. lunaris (Ehr.) Grunow	+	+	-
E. validia Hustedt	++	-	-
Fragilaria brevistriata Grunow	+	++	-
F. copucina Desmazieres	+	+	+
F. intermedia Grunow	+	+	++
F. pinnate Ehrenberg	-	-	+
Gomphonema acuminatum Ehrenberg	+	-	++
G. angustatum var.undulata Grunow	-	-	++
G. constrictum Ehrenberg	+	+	+
G. constrictum var.capitata (Ehr.) Cleve	++	++	-
G. gracile Ehrenberg	++	++	-

G. intricatum var. pumila Grunow	-	++	++
G. intricatum var. vibro (Ehr.) Cleve	-	++	++
G. lanceolatum Ehrenberg	++	++	-
G. longiceps Ehrenberg	-	-	+
G. olivaceum (Lyng.) Kützing	++	++	++
G. parvulum (Ehr.) Grunow	++	++	++
Gyrosigma acuminatum (Kütz.) Rabenhorst	+++	-	++
G. attenuatum (Kütz.) Rabenhorst	+	+	++
G. distrodum var.parkeri Harrisson	-	-	++
G. tenuirostrum (Grun.) Cleve	-	-	++
G. spenceri (W. Smith) Cleve	+	++	++
Mastogloia braunii Grunow	++	-	-
M. smithii var. amphicephala Grunow	-	-	++
M. smithii var. lacustris Grunow	++	-	+
Meridion circulare Agardh	++	++	-
Naviula botanica Grunow	+++	+++	+++
N. cincta (Ehr.) Kützing	+++	++	++
N. cryptocephala Kützing	++	-	-
N. cuspidata Kützing	-	-	++
N. grimmei Krasske	-	++	-
N. grigaria var.thurholmeinsis(j.Dannf.)Cleve	+	++	-
N. inflata Donkin	-	++	-
N. parva Ralfs	++	++	++
N. radiosa Kützing	++	++	++
N. radiosa var. tenella (Bréb.) Grunow	-	-	++
N. rhyncocephala Kützing	+	+	++
N. spicula (Dick.) Cleve	+++	-	+
N. viridula Kützing	-	-	++
Nitzschia amphibia Grunow	++	++	++
N. apiculata (Greg.) Grunow	-	+	-
N. dissipata (Kütz.) Grunow	++	-	-
N. fasciculata Grunow	++	++	-
N. frustulum Kützing	-	+++	-
N. gracilis Hantzsch	++	-	-
N. hungarica Grunow	++	++	++
N. intermedia Hantzsch ex Cleve & Grunow	-	-	++
N. obtusa W. Smith	+	-	-
N. palea (Kütz.) W. Smith	++	+	+
N. punctata (W. Smith) Grunow	++	++	++
N. sigma (Ehr.) W. Smith	++	+	++
N. thermalis Kützing	-	+	++
Pinnularia lata (Bréb.) Smith	++	-	++
P. nobilis (Ehrenberg)Ehrenberg	-	-	+
P. viridis (Nitzsch) Ehrenberg	-	+	-
Pleurosigma salinarum Grunow	-	-	+
Rhoicosphenia curvata (Kütz.) Grunow	-	+	-
Rhopalodia gibba (Ehr.) Müller	+	-	++
Surirella lineavis Var.contricta-Grunow	-	-	++
S. ovta Gregory	+	+	-
S. tenra Gregory	-	+	-
Stauroneis anceps Ehrenberg	+	-	-
Synedra acus var. radians Kützing	++	+	+
S. affinis Kützing	++	-	++
S. fasciculata (Kütz.) Grunow	++	+	++
S. rumpens Kützing	-	++	-
S. ulna (Nitz.) Ehrenberg	++	+	++
S. ulna var. biceps Kützing	-	++	-
S.vaucheria kutzing	-	+	++
Tabellaria fenestrata(lyng)Ruetzing	-	-	+
DINOPHYCEAE			
Ceratium hirundinella(muell)Dujardin	++	+	++
Glenadinium armatum levander	+	-	+
Peridinium cinctum(Muller)Ehrenberg	+	+	-
P. inconspicuum.Lemm	++	++	-
CHRYSOPHYCEAE			
Dinobryon sertularia Ehrenberg	+	-	-
Mallomonas acarooides Party	+	-	+
Mallomonas sp.	-	-	+
XANTHOPHYCEAE			
Characiopsis.spinifer	-	-	+
RHODOPHYCEAE			

Compsopogon sp.	+	-	-
EUGLENOPHYCEAE			
Euglana acus var.rigida Huebner	+	+	+
E. elonga schewiakoff	++	-	+
E. minuu Prescott	-	-	+
E. virids (o.f.muller)Ehrenberg	+	-	-
Phacus acuminatus Stoken	-	+	+
+ (0 - 1) Cell x 103 / Cm 2 ++ (1 – 5) Cell x 103 / Cm 2 +++ (> 5) Cell x 103 / Cm 2			

The results of the qualitative study coincided with the results of the quantitative study of the total number of epipelic algae cells, with the diatoms algae row outperforming the rest of the other rows in all sampling sites (Fig. 3) , also, congruent results were recorded, identical to the qualitative study, as the numerical density of the Cyanophyceae algae prevailed over the numerical density of the Chlorophyceae algae. A' recorded the highest total number of epipelic algae at site 1 in the Pennales row (159.9 x 103 cells/cm²) (64.8%), where the pennales diatoms recorded an absolute superiority in all studied sites, while the Cyanophyceae algae row recorded the highest numbers of epipelic algae at site 1 The row of pennales diatoms recorded the highest numbers (49.5 x 103 cells/cm²) (20.1%), while the Chlorophyceae recorded the highest number (35.7 x 103 cells/cm²) (17.4%), while algae recorded centrales diatoms had the highest number (56.7 x 103/cm3) (22.9%), and the rest of the other rows had a small number of total cells.

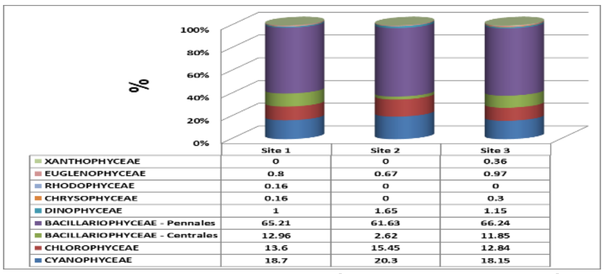

Fig. (3) locational variations of the percentages of the total number of epipelic algae cells (cells x 103/cm2) and their main groups in the sampling sites in the Baghdad Island tourist lake for the period from November 2021 to May 2022.

A group of species recorded percentages exceeding 3% of the total number of epipelic diatoms cells (Fig. 4), where *Cyclotella ocellata* recorded absolute dominance in site 1, while a group of dominant species were recorded in site 2, namely *Bacillaria paradoxa*. And *Navicul botanica*, *Nitzschia fasciculate*, and *N. palea*. In site 3, *Cyclotella ocellata*, *Cyclotella stelligera* and *Navicula botania* were recorded.

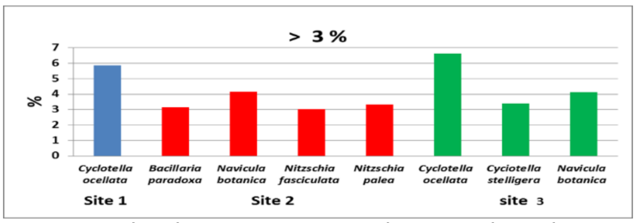

Fig. (4) The dominant species whose total numbers showed percentages that exceeded (3 %) in the sampling sites during the current study.

Biodiversity Indices: The seasonal and locational variations of the richness Index values showed a noticeable variation by recording their highest values in site 3 and for all seasons of the year, where the highest rate of richness index was recorded at 17.99 in site 3, while the lowest average of the index values was recorded at 14.82 in site 1 (Fig. 4). The highest value was recorded at 19.80 (site 3) in the spring season, and the lowest value was recorded at 13.84 (site 2) in the winter season. The richness of species in site 3 may be due to the impact of this site on human activities from the movement of tourists, and these activities may add to the water many plant nutrients that encourage the growth of algae and its richness (Al-Jumaili, 2021). Therefore, the lake water, according to the results of the current study, is considered medium-rich in species.

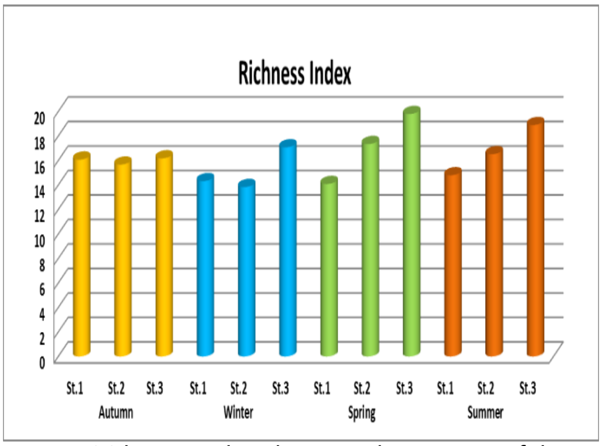

Fig. (4) locational and seasonal variations of the Richness Index values in the sampling sites of the Baghdad Island tourist lake for the period from November 2021 to May 2022.

The seasonal and locational variations of Shannon index values showed a noticeable variation in their values, where the highest rate was recorded at 4.14 in Site 3, while the lowest rate was recorded at 3.84 in Site 1, and the highest values of the index were 4.21 (site 3) in the winter season, and the lowest values were recorded at 3.77 (site 1) In the winter and spring seasons (Fig. 5). According to the results of Shannon's index recorded in the current study, the lake water is considered to be of high biological diversity in most seasons and study sites, and the lake water suffers from little to very little pollution. And Shannon's index values indicate the inverse relationship between diversity and the degree of water pollution, which leads to changes in the dominant societies and their replacement with sensitive species to the apecies that are resistant to pollution as a result of increased pollution (Shevchenko et al., 2017).

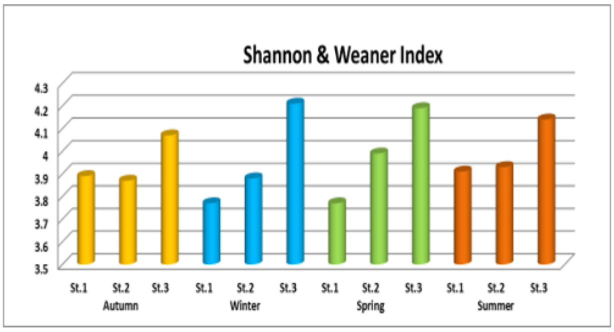

Fig. (5) locational and seasonal variations of the Shannon and Weaner Index values in the sampling sites of the Baghdad Island tourist lake for the period from November 2021 to May 2022.

The similarity index values showed that no high differences were recorded between modeling sites in general, as well as between sites during the current study chapters. Where the highest similarity was recorded by 39.33% between sites 1 and 2 (Tab 6.), and the index values converged during the different seasons (Tab. 7), where the highest similarity was recorded by 22.98% and 22.15% between sites 1 and 2 in the fall and spring seasons, respectively. In the winter season, the highest similarity was 21.19 % between sites 1 and 3, while the summer season recorded the highest similarity of 21.38 % between sites 2 and 3.

The closeness of the similarity ratios between the sites in general and the convergence of the similarity ratios during the different seasons may be attributed to the small area of the lake and the convergence of the sampling sites in addition to the similarity of the nature of the sites and their geographical location (Al-Ta'i and Al-Qusair, 2013; Akoto et al., 2008).

Tab. (6) Jaccard's Similarity Index (%) was evaluated between sampling sites in the Baghdad Island tourist lake for the period from November 2021 to May 2022.		
Site 2	Site 1	
	39.33	Site 2
36.06	34.35	Site 3

Tab. (7) Jaccard's Similarity Index was assessed for all seasons between sampling sites in the Baghdad Island Lake Tourist Attraction for the period from November 2021 to May 2022.		
Site 2	Site 1	Autumn 2021
	22.98	Site 2
19.35	16.77	Site 3
Site 2	Site 1	Winter 2022
	14.49	Site 2
12.26	21.19	Site 3
Site 2	Site 1	Spring 2022
	22.15	Site 2
21.15	17.81	Site 3
Site 2	Site 1	Summer 2022
	19.01	Site 2
21.38	19.28	Site 3

4. Conclusion

The physical and chemical characteristics were reflected in the results of the biodiversity of epipelic algae in the waters of the lake of Baghdad Island tourism and the influence of the lake water by the waters of the Tigris River feeding it, where the class of blue-green algae prevailed over the class of green algae and that the lake water has medium bio-diversity, with a medium richness of species and Convergence in the rates of similarities between sites and seasons of study due to the small size of the lake.

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