BULLETIN OF THE IRAQ NATURAL HISTORY MUSEUM
Iraq Natural History Research Center & Museum, University of Baghdad
https://jnhm.uobaghdad.edu.iq/index.php/BINHM/Home

Online ISSN: 2311-9799, Print ISSN: 1017-8678

Bull. Iraq nat. Hist. Mus.
(2025) 18 (4): 929-942. https://doi.org/10.26842/binhm.7.2025.18.4.0929

ORIGINAL ARTICLE

ASSESSMENT OF ORGANIC POLLUTION IN EAST AL-HAMMAR MARSH USING PALMER'S ALGAL INDEX, BASRAH, SOUTHERN OF IRAQ

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Received: 14 May 2025, Revised: 1 Nov. 2025, Accepted: 3 Nov. 2025, Published:20 December 2025

ABSTRACT

The study aimed to evaluate the water quality of East Al-Hammar Marsh in Basrah, Iraq, by utilizing phytoplankton as a biological indicator and applying Palmer's Algal Pollution Index Phytoplankton samples were collected using a 20 µm mesh size net from three stations (S1 in Harir, S2 in Al Salal, and S3 in Al Barka) in East Al-Hammar Marsh between 2019 and 2020 during the winter months (December, January, and February) and summer months (June, July, and August). Palmer's Index was used to evaluate the water quality of Al-Hammar Marsh based on both algae genus and species composition. The overall scores for the S1, S2, and S3 algae genera pollution index in the winter months were 35, 28, and 30 respectively. In summer, the scores for the same stations were 21, 15, and 22, respectively. For the algae species pollution index, winter scores were 16, 20, and 22, and summer scores were 21, 18, and 16, respectively. According to the index, a total score of 15 to 20 indicates an organic pollution, and more than 20 indicates a high organic pollution.The genera with tolerance to pollution were Cyanophyta, like *Oscillatoria* Vaucher ex Gomont,1892 and *Phormidium* Kützing ex Gomont,1892; Bacillariophyta, like *Cyclotella* Kützing, 1846 *Gomphonema* C.G. Ehrenberg,1832, *Navicula* Bory de Saint-Vincent,1822, *Nitzschia* Hassall, 1845, *Synedra* Ehrenberg,1830, and Chlorophyta, like *Pandorina* Bory de Saint-Vincent, 1824, *Scenedesmus* Meyen, 1829, *Ankistrodesmus* Corda, 1838, *Chlamydomonas* Ehrenberg, 1833, and Euglenophyta, like *Euglena* Ehrenberg, 1830 and *Phacus* Dujardin, 1841. The Palmer index was an important instrument for displaying the probability of pollution in surface water. Compared to the species index, the Palmer index of genera was more useful for the same sampling station, the pollution in the form of the Palmer index varies slightly over time from winter to summer or geographically along the water courses. Generally speaking, organic contamination affects the Al-Hammar Marsh's surface water in most of the sampled stations.

Keywords: Algae, Al-Hammar, Bioindicator, Palmer's Index, Phytoplankton.

INTRODUCTION

Iraqi marshes are significant because of their usefulness to economy, society, and biodiversity. They give coastal fisheries a genuinely global dimension by supporting them, and they serve millions of birds traveling among Siberia and Africa as well as being a stable habitat for numerous rare species of plants, fish, birds, and invertebrates (Maulood and Hassan, 2021). Algal cells have the capacity to accumulate contaminants from their immediate surroundings and retain them within the body's cells (Wang and Dei, 2001). Since algae are the initial food in the food chain, an increase in intracellular organic pollutants affects the number of algae. Because of their short lifespan and quick response to changes in the aquatic environment, phytoplankton provide early warning signs of water pollution, such as changes in population dynamics, chlorophyll-a levels, and phytoplankton composition. These variations can indicate changes in the amounts of dissolved oxygen and nutrients, and general water quality, offering vital information about possible contamination incidents (Ganai and Praveen, 2014; El-Kassas and Gharib, 2016).

A biological indicator is a class or assembly of organisms that exhibit evidence of being impacted by environmental stress brought on by human activity or the breakdown of a biological system. (Barbour *et al*., 1999; Bhatt *et al.*, 1999; Ganai and Praveen, 2014; El-Kassas and Gharib, 2016). The algal groups react quite strongly to even a small change in the water's quality. Phytoplankton's number and build are highly influenced by the environmental elements of their habitat, including dioxide (CO_2), sunshine, and nutrients. The biomass and dispersion of phytoplankton through the body of water are impacted by these factors (Dimowo, 2013; Shams and Ghorbani, 2013), when evaluating the water body's resources and biodiversity, the existence of algae is crucial. Due to their extreme sensitivity to shifting environmental conditions, assessing the distribution and existence of phytoplankton helps to clarify environmental features and the effects of water quality changes on algal communities (Huang *et al.*, 2022). The phytoplankton in water body reflects the ecological factors and thence can be utilized as water quality biological indicators (Nurruhwati *et al.*, 2017; Wagh *et al.*, 2022). Palmer's algal pollution index is a method that uses algal communities to describe the degree of organic contamination in freshwater bodies (Palmer, 1969, Alombro *et al.*, 2023). There are no prior Iraqi studies on the palmer algal index in Al-Hammar Marsh, and research on phytoplankton biodiversity in this area remains limited (Jaffer *et al.*, 2023).

Al-Kanani and Al-Essa (2018) studied Palmer's Index to the Assessment of Shatt Al-Arab and showed high levels of organic pollution. According to the present study, Stations 1, 2, and 3 had scores above 20, indicating downstream home usage that degrades water quality. In Egypt El-Kassas and Gharib (2016) and Salem *et al.* (2017) noted that biological evaluation utilizing phytoplankton, exemplified by Palmer's Algal Index, helps determine pollution levels and variations in water quality within aquatic systems. Palmer's Algal Contamination Index was used by Alombro *et al.* (2023) to assess organic contamination in the rivers of Cotabato City, Philippines, and validated the index's adaptability for water quality monitoring in different parts of the world.

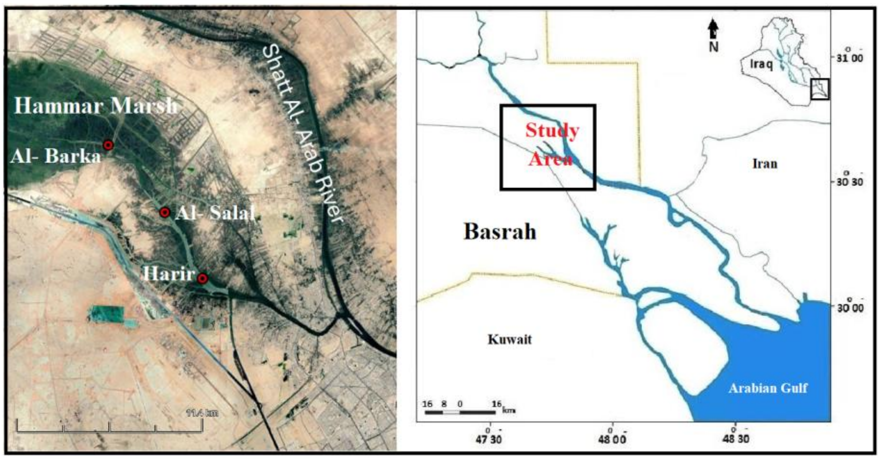
The studies on limnology, water quality, water quality index, phytoplankton and primary production in Iraqi marshes remains relatively limited. Talib (2017) studied the ecological conditions of the Al-Hammar marsh after a case of flood. Al-Nagar *et al*. (2020) studied Water Quality Index (WQI) as an indicator of the East Hammar marsh following a significant rise in salinity during the summer of 2018. Dhaidan *et al*. (2021) evaluated the restoration strategy for Al-Hammar Marsh using indicators derived from satellite imagery; Maulood and Hassan (2021) studied phytoplankton and estimated primary production in various Iraqi marshes.

This study aimed to use the phytoplankton as a biological indicator to assess the organic pollution of Al-Hammar Marsh by Palmer's Algal indicator.

MATERIALS AND METHODS

Study area: Sited in southern Iraq, Al Hammar Marsh is one of the largest wetlands in the country. Its longitudinal spans 132 km, flowing from the village of Al-Hammar, west of Dhi Qar Province to the east of Basra Province, and ends at the Garmat Ali port, where it empties into the Shatt al-Arab River. Its width varies from 26 to 35 km (Al-Mansouri, 2008). After deciding on the eastern lagoons of Al-Hammar, three sampling stations were found, and the GPS (Global Positioning System) of such stations is as follow Harir- 30°36'15.38"N 47°40'42.87"E, Al Salal- 30°38'36.80"N 47°39'9.36"E and Al Barka- 30°41'6.51"N 47°36'46.41"E (Map 1).

Collecting of samples and Examination: Phytoplankton samples were collected using a 20 µm mesh size net, which was pulled through the water for 15 minutes at a controlled speed. The samples were then transferred to a polyethylene bottle and preserved with a 4% formalin solution. Non-diatom species were examined directly. For diatom species, all organic material and siliceous frustules were oxidized and removed to observe the valve structure for microscopic analysis and species identification. Each algal genus with a density greater than 50 cells per 1 ml sample was noted and included in the index (Salem *et al*., 2017). Algae were identified according to the classification systems of Desikachary (1959), Prescott (1982), and Guiry and Guiry (2019). The study of the algal genera includes the comparison between the winter months (December, January, and February) and the summer months (June-August) from the three different stations; S1 (Harir), it reflects the marsh's entry and is distinguished by the appearance of sizable mudflats on the eastern and western banks during the ebbing season, which are said to be an important attraction for numerous water bird groups. Fishing is the primary human activity that affects this area, S2 is (Al-Salal distinguished by the muddy bank when the water level is low (Habeeb *et al*., 2018). Numerous human activities, particularly fishing, fodder cutting, and buffalo grazing, are supported in this area. S3 is an open water and looks like vast mudflats during low tide. Furthermore, it offers a useful site for various human endeavors, such as the cutting of fodder, fishing, and buffalo grazing, and affects organic pollution in the water. According to Palmer (1969), it depends on a list of algae taxa that shows organic pollution, and calculation of organic pollution for the aquatic environment indicates higher organic contamination if scores are ≥ 20 (Tab.1).



Map (1): Shows studied stations from East Al-Hammer Marsh, from Basrah City.

Table (1): Pollution index measure (Palmer, 1969).

Pollution Index	Status of Pollution
< 15	Very light organic pollution
15 – 20	Organic pollution
>20	High organic pollution

RESULTS AND DISCUSSION

A total of 150 species belonging to 70 genera of algae were recorded from three sampling stations, including 16 genera and 16 species that are tolerant of organic pollution. Palmer (1969) created a list of genera and species of algae that indicate organic pollution. This list contains 20 genera and 20 species. Palmer (1969) and Iloba (2020) mentioned that if scores are > 20, the status of pollution was high. There are four groups of algae that are tolerant of pollution recorded after the microscopic examinations in Al-Hammar Marsh. The recorded Phytoplankton were grouped under Cyanophyceae, Chlorophyceae, Euglenophyceae, and Bacillariophyceae. Most of genera and species are registered in Tables (2, 3) and Plate (1). A score in algal genera pollution index of S1, S2, and S3 in winter months were 35, 28, and 30, respectively, particularly during the winter, when anthropogenic and animal activity probably increases the loads of organic materials and nutrients. The scores for the same stations' algae genera pollution index in summer months were 21, 15, and 22, respectively (Tab.3). An increase in water inflow to the Al-Hammar Marsh (Jaffer *et al.*, 2023) may have improved water quality through enhanced flow, dilution, and changes in biological and chemical processes (Shahare, 2017), On the other hand, higher temperatures and intense evaporation could explain the fall in water quality during the summer (Mohamed *et al.*, 2014; Salem *et al.*, 2017).

Furthermore, the warming effect of climate change, the water exchange cycles brought on by human activity, and the slowing of wind speed can all make phytoplankton more sensitive to nutrients (Yang *et al.*, 2005; Barinova *et al.*, 2016). While scores from the Algae Species Pollution Index in winter months were 16, 20, and 22, respectively, and in summer months were 21, 18, and 16, respectively (Tab.3). The algae in station 1, 2 and 3 reached highest point of organic contamination. The domination of genus *Oscillatoria* Vaucher ex Gomont 1892, *Euglena* Ehrenberg, 1830, *Phacus* Dujardin, 1841, *Cyclotella* Kützing, 1846, *Navicula* Bory de Saint-Vincent, 1822, and *Nitzschia* Hassall, 1845, is deemed to be index of organic pollution (Diag. 1), and this coincides with Al-Kanani and Al-Essa (2018).The genera *Euglena* and *Oscillatoria* are trustworthy markers of eutrophication due to their strong tolerance for pollution and have high grade in Palmer's measure, including *Euglena gracilis* Klebs, 1883*, Euglena viridis* (O.F. Müller) Ehrenberg, 1830, *Oscillatoria chlorine* Kützing ex Gomont, 1892, *Oscillatoria limosa* C. Agardh ex Gomont, 1892, and *Oscillatoria tenuis* C.Agardh ex Gomont 1892 (Dubey *et al.*, 2024) (Diag. 2).

The genera *Ankistrodesmus, Navicula,* and *Nitzschia* are found in water organically contaminated, and the common algae *Nitzchia* is deemed to be an organic tolerant alga that acts as organic contamination indicator in marine and freshwater environment (Xia *et al.*, 2020), and the presence of organic substrates and nutrients regulate the abundance of these diatoms (Kim *et al.*, 2019). The capacity of some algae species to withstand changes in water level and desiccation is a key factor in their success in wetland environments (Holzinger and Karsten, 2013).

Water levels can vary several times in a little month or stay the same for years. When exposed to a changing moisture system, algae need to adapt in order to withstand the harshness of these conditions (Wehr and Sheath, 2003) .

Table (2): Algae genus recorded at east Al-Hammer Marsh according to Palmer (1969).

No.	Species	S1-w	S1-s	S2-w	S2-s	S3-w	S3-s
1	*Anacystis* Meneghini, 1837	-	-	-	-	-	-
2	*Ankistrodesmus* Corda, 1838	2*	2 *	2*	-	2*	-
3	*Chlamydomonas* Ehrenberg, 1833	4*	-	4*	-	4*	-
4	*Chlorella* Beijerinck, 1890	3*	-	3*	-	3*	-
5	*Closterium* Nitzsch,1817		-		-	1	-
6	*Cyclotella* Kützing, 1846	1*	1*	1*	1*	1*	1*
7	*Euglena* Ehrenberg, 1830	5*	5*	5*	5*	5*	5*
8	*Gomphonema* C.G. Ehrenberg,1832	-	-	-	1*	-	-
9	*Lepocinclis* Perty,1852	-	1*	-	-	-	-
10	*Melosira* Agardh,1824	-	-	-	-	-	-
11	*Micractinium* Fresenius,1858	-	-	-	-	-	-
12	*Navicula* Bory de Saint-Vincent,1822	3*	3*	3*	3*	3*	3*
13	*Nitzschia* Hassall, 1845	3*	3*	-	3*	-	3*
14	*Oscillatoria* Vaucher ex Gomont 1892	5*	5*	5*	5*	5*	5*
15	*Pandorina* Bory de Saint-Vincent, 1824	1*	-	-	1*	-	1*
16	*Phacus* Dujardin, 1841	2*	-	-	2*	-	2*
17	*Phormidium* Kützing ex Gomont,1892	-	-	1*	-	-	-
18	*Scenedesmus* Meyen, 1829	4*	4*	4*	4*	4*	4*
19	*Stigeoclonium* Kützing, 1843	-	-	-	-	-	-
20	*Synedra* (=*Ulnaria*) Ehrenberg,1830	2*	-	-	-	2*	-
	Total score	35	24	28	25	30	24

[w=winter, s= summer, *=score number for each genus].

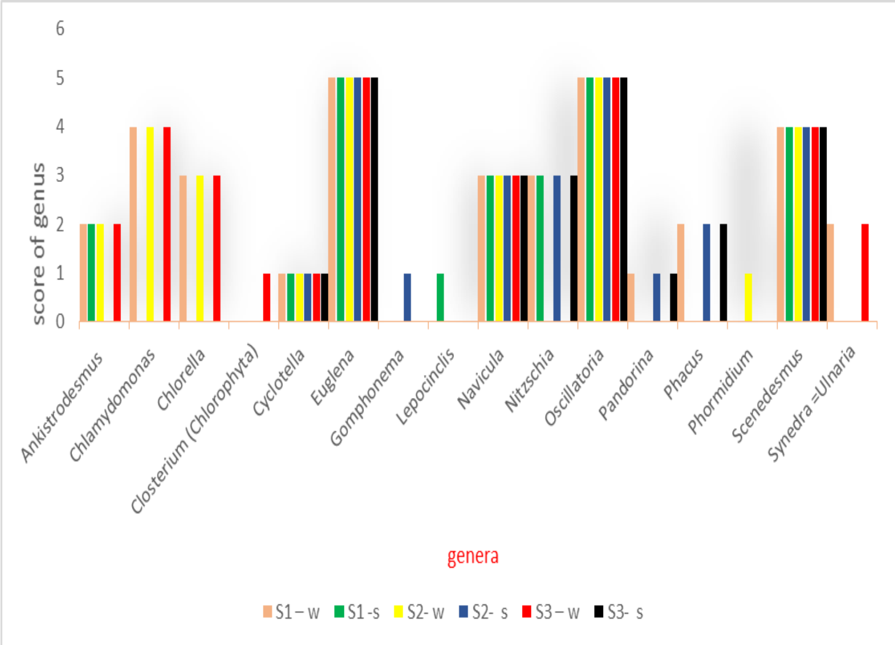


Diagram (1): Algae genera recorded at East Al-Hammer Marsh according to Palmer (1969).

Table (3): Algae species recorded at East Al-Hammer Marsh according to Palmer (1969).

No.	Species	S1-w	S1-s	S2-w	S2-s	S3-w	S3-s
1	*Ankistrodesmus falcatus* (Corda, 1839) Ralfs, 1848	3*	3*	3*	-	3*	-
2	*Arthrospira jenneri* Forti, 1907	-	-	-	-	-	-
3	*Chlorella vulgaris* Beijerinck, 1890	2*	-	2*	-	2*	-
4	*Cyclotella meneghiniana* Kützing, 1844	2*	2*	2*	2*	2*	2*
5	*Euglena gracilis* Ehrenberg, 1830	-	1*	1*	-	1*	-
6	*Euglena viridis* Ehrenberg, 1834	1*	-	-	1*	-	-
7	*Gomphonema parvulum* (Kützing) Kützing, 1844	-	-	-	1*	-	-
8	*Melosira varians* (Ehrenberg) Kütz., 1844	-	-	-	-	-	-
9	*Navicula cryptocephala* Kützing, 1844	1*	1*	1*	1*	1*	1*
10	*Nitzschia acicularis* (Kützing) W.Smith, 1853	1*	-	-	-	1*	-
11	*Nitzschia palea* (Kützing) W.Smith, 1853	-	5*	-	5*	-	5*
12	*Oscillatoria chlorina* (C. Agardh ex Gomont) Gomont, 1892	-	-	-	1*	-	-
13	*Oscillatoria limosa* C.Agardh ex Gomont, 1892	-	1*	1*	-	-	-
14	*Oscillatoria princeps* Vaucher ex Gomont, 1892	1*	-	1*	-	1*	1*
15	*Oscillatoria pulrida* Lemm., 1889	-	-	-	-	-	-
16	*Oscillatoria tennis* Lemmermann, 1900	-	4*	-		4*	
17	*Pandorina morum* (O.F.Müller) Bory de Saint-Vincent, 1824	3*	-	-	3*	-	3*
18	*Scenedesmus quadricauda* (Turpin) Brébisson, 1838	4*	4*	4*	4*	4*	4*
19	*Stigeoclonium tenue* (Hildebrandt) Kützing, 1843	-	-	-	-	-	-
20	*Synedra ulna* (=*Ulnaria danica*) (Ralfs ex Ralfs) Compère,1983	3*	-	-	-	3*	-
	Total score	21	21	15	18	22	16

[w=winter, s= summer, *=score number for each genus].

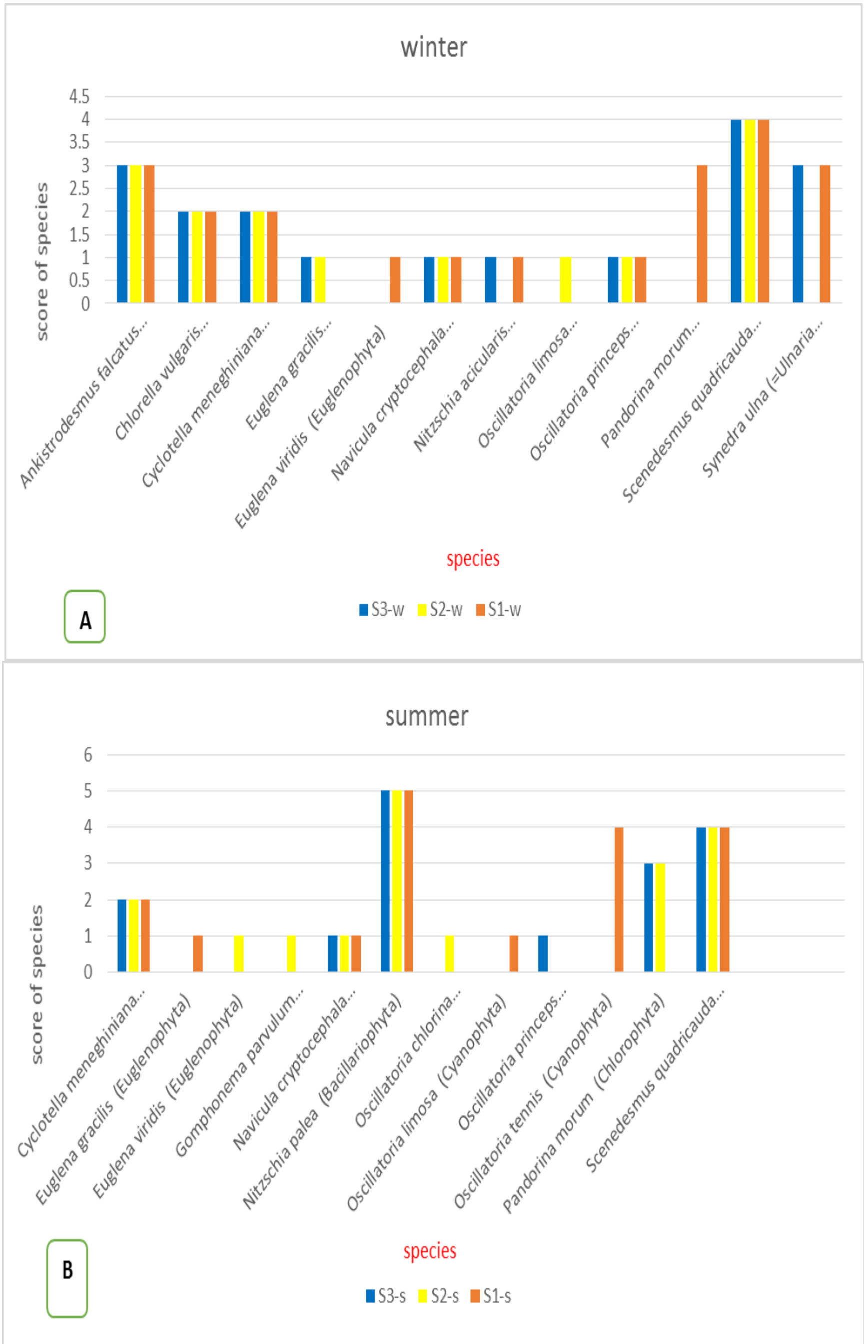


Diagram (2): Algae species recorded at East Al-Hammer Marsh according to Palmer (1969); (A) During winter, (B) During summer.

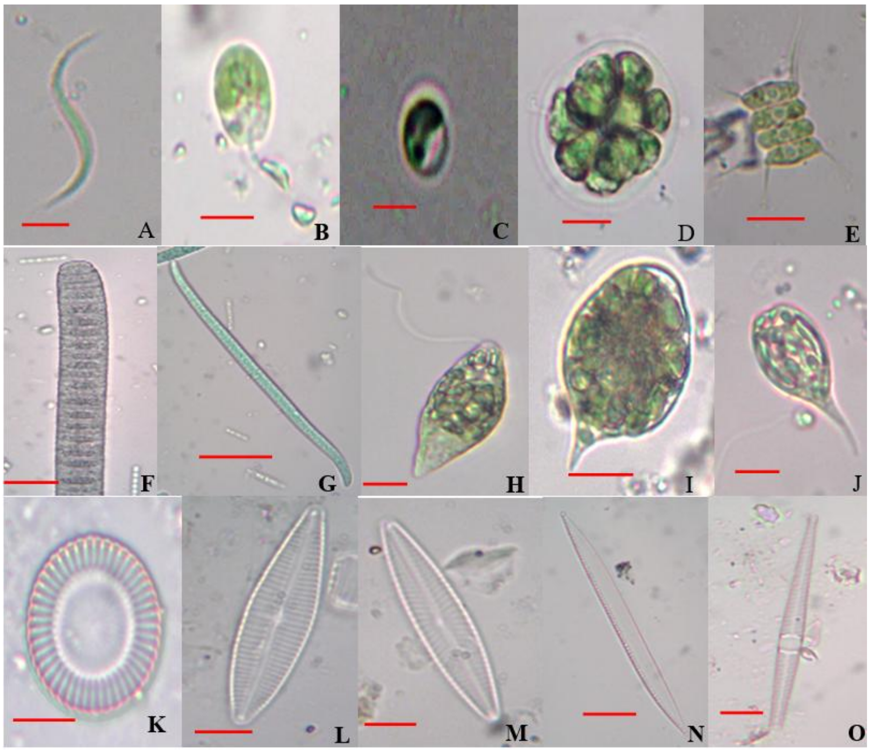


Plate (1): Algal taxa were recorded at East Al-Hammer Marsh according to Palmer index. [A-*Ankistrodesmus*, B-*Chlamydomonas*, C- *Chlorella*, D- *Pandorina*, E- *Scenedesmus*, F-*Phormidium*, G-*Oscillatoria*, H- *Euglena*, I- *Lepocinclis*, J- *Phacus*, K- *Cyclotella*, L-*Gomphonema*, M- *Navicula*, N-*Nitzschia*, O- *Synedra*. [Scale bar 10µm].

CONCLUSIONS

The Al-Hammar Marsh is typically affected by organic pollution, with pollution levels differing somewhat between winter and summer and between stations, according to a study that used phytoplankton as bioindicators, specifically Palmer's Index. The high level of organic contamination in the majority of studied sites is confirmed by the presence of pollution-tolerant taxa such as *Oscillatoria*, *Euglena*, *Navicula*, and *Nitzschia*. These results highlight the marsh's susceptibility to organic contaminants, which are probably caused by human activities like grazing and fishing. In this wetland ecosystem, the Palmer Index was a useful tool for identifying organic pollutants and evaluating the quality of the water. The Palmer Index is favored for evaluating algal contamination at the genus level because algae can be identified more quickly and easily at the genus level than at the species level. This makes it more useful and efficient for use in routine water quality monitoring and to recommend that water quality be checked using biological markers, such as phytoplankton diversity. In addition to algae, other bioindicators, such as fish and macroinvertebrates, should be included for a more comprehensive assessment of ecological health. Limiting the quantity of domestic and agricultural waste discharged into wetlands, and regulating human activities such as fishing, buffalo grazing, and fodder cutting in their vicinity especially during the winter months when pollution levels are higher. Educate residents and stakeholders on the impact of organic pollutants on maintaining water quality.

ACKNOWLEDGEMENTS

We are grateful to the Department of Environmental Sciences at the College of Science, University of Basrah, for assisting us in completing this study.

CONFLICT OF INTEREST STATEMENT

"There isn't any conflict of interest for the researchers."

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تقييم التلوث العضوي في هور شرق الحمار بمحافظة البصرة، العراق باستخدام مؤشر بالمر للطحالب

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الاستلام: 2025/5/14، المراجعة: 2025/11/1، القبول 2025/11/3، النشر: 2025/12/20

الخلاصة

هدفت الدراسة الحالية إلى تقييم جودة المياه في هور شرق الحمار في البصرة، العراق، من خلال استخدام الهائمات النباتية كمؤشر بيولوجي وتطبيق مؤشر بالمر للطحالب. تم جمع عينات الهائمات النباتية من ثلاث محطات (S1 في حرير، S2 في الصلال و S3 في البركة) في هور شرق الحمار بين عامي 2019 2020. وتم أخذ العينات خلال أشهر الشتاء (كانون الاول، كانون الثاني وشباط) وأشهر الصيف (حزيران، تموز، و آب) يعتمد مؤشر بالمر على بعض اجناس و انواع الطحالب.

كانت الدرجات العامة لمؤشر تلوث اجناس الطحالب في المحطات S1 و S2 و S3 في أشهر الشتاء 35 و 28 و 30 على التوالي، وفي الصيف كانت الدرجات لنفس المحطات 21 و 15 و 22 على التوالي. بالنسبة لمؤشر تلوث بالمر لأنواع الطحالب، كانت الدرجات في الشتاء 16 و 20 و 22، و في الصيف 21 و 18 و 16 على التوالي. وفقًا للمؤشر، فإن الدرجة الإجمالية من 15 إلى 20 تشير إلى تلوث عضوي، وأكثر من 20 تشير إلى تلوث عضوي مرتفع. الأجناس التي تتحمل التلوث وتعود الى الطحالب الخضر المزرقة، مثل:

Oscillatoria Vaucher ex Gomont,1892

Phormidium Kützing ex Gomont,1892

والتي تعود الى الطحالب العصوية مثل:

Cyclotella Kützing, 1846

Gomphonema C.G. Ehrenberg,1832

Navicula Bory de Saint-Vincent,1822

Nitzschia Hassall, 1845

Synedra Ehrenberg,1830

اما التي تعود الى الطحالب الخضراء مثل:

Pandorina Bory de Saint-Vincent, 1824

Scenedesmus Meyen, 1829

Ankistrodesmus Corda, 1838

Chlamydomonas Ehrenberg, 1833

والطحالب اليوغلينية مثل:

Euglena Ehrenberg, 1830

Phacus Dujardin, 1841

كان مؤشر بالمر أداة مهمة لعرض احتمالية التلوث في المياه السطحية بالمقارنة مع مؤشر الأنواع، كما ان مؤشر بالمر للأجناس أكثر فائدة لنفس محطة أخذ العينات، حيث يتفاوت التلوث في شكل المؤشر قليلاً على مر الزمن من الشتاء إلى الصيف أو جغرافياً على طول مجاري المياه. وبشكل عام، يؤثر التلوث العضوي على مياه السطح في هور الحمّار في معظم محطات أخذ العينات.