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Original Article

New seven records of Euphrates River algae in Iraq

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Abstract

Many samples were collected from five sites (Al-Khasafa, Hadithah, Al-Haqlaniya, Aloose, and Jubba), located on both sides of Euphrates River and Hadithah Reservoir in Anbar province, Iraq in November 2017. About seven new freshwater algae were determined for the first time in Iraq. Of five genera, seven phytoplankton species were identified. *Characium debaryanum*, *Characium gracilipes*, *Chlamydomonas cienkowskii* and *Oocystis apicurvata* belong to Chlorophyta, while *Phacus acuminatus* var. *drezoolskii* and *Monomorphina pseudonordstedtii* belong to Euglenophyta. Only one genus of Xanthophyta, *Stipitococcus* sp., was diagnosed in districts of the study. This work is considered the first record of new river algae in Iraq. Thus, the aim of this study is to add new data about the biodiversity of phytoplankton of Euphrates River in Iraq.

Keywords: Anbar, aquatic ecosystem, biodiversity, freshwater, phytoplankton

1. Introduction

Algae are an essential component of aquatic ecosystems such as rivers, springs, lakes, and streams because they reflect the health of their environment through their distribution, abundance, and productivity (Stevenson, Both well, & Lowe, 1996). Algae play an essential role in the environment. Recently, algae are using widely as healthy alternative sources of foods, antibiotics, plant fertilizers and bioenergy.

Algae grow in various habitats and locations, but they become cosmopolitan in distribution and growing almost everywhere in the world (Dalal & Nisal, 2012). Algologists of Iraq have studied on distribution, collection, and identification of freshwater algae in various Iraqi aquatic environments, especially in rivers and marshlands, the River Euphrates is one of the forty longest rivers of the world and it has length of 2,940 km (Vander, 1975). However, a complete list of Iraqi phytoplankton flora was not yet completed. Also, only five checklists were published; the last one was in 2013 by Maulood, Fikrat, Ali, Janan and Abbas (2013), which included 2,647 species. Algal species compositions were a main point of interest in some studies; pioneer limnologists in Iraq made morphological and taxonomic studies on different groups of algae in various aquatic systems.

New algae recordings in the Iraqi aquatic environment are still being discovered by many researchers, such as Al-Hussieny (2017a), and Aziz and Muhammed (2016). In general, the environment of phytoplankton in Iraq requires further studies because of diversity the vast nature of inland water sources. The freshwater algae of the upper region of

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Euphrates River in Iraq are still poorly investigated. Few papers were published about algae of this area (Al-Mahdawi & Ali, 2014). Thus, this screen was achieved to the knowledge of freshwater algae for the upper region of Euphrates River in Iraq to complete part of the Iraqi algal data. This study aims to add new data about the biodiversity of phytoplankton of Euphrates River in Iraq.

2. Materials and Methods

2.1. Description of the study area

As shown in Figure 1, five sites are Al-Khasafa, Hadithah, Al-Haqlaniya, the village of Aloose and village of Jubba, have been described in the following. Location 1: The first site was in Al-Khasafa area in the South of Hadithah Reservoir. It was 2 km away from the Hadithah Dam Body, at coordinates 34°14'17.93" N and 42°21'57.83" E. The depth of the water at this site was about 24 m, and the banks were characterized by a scarcity vegetative cover. Location 2: The second site was located on the Euphrates River in Hadithah at coordinates 34°11'28.89" N and 42°22'56.51" E. The water depth reached eight meters, and the site was characterized by the abundance of agricultural fields on both sides of the river. Location 3: The third site was located in Al-Haqlaniya district near the water complex located about 8 km from the dam. At coordinates 34°5'40.51" N and 42°22'11.96" E, the depth of water was ranging 1-5 m. This area was characterized by the presence of agricultural fields with the abundance of *Phragmites australis* reed plant on the riversides. Location 4: The fourth area located in the village of Aloose at coordinates 34°0'52.12" N and 42°25'5.71" E. The site was characterized by a low density of population and the existence of few agricultural fields. Location 5: The last site located in the Jubba village at coordinates 33°54'19.91" N and 42°33'17.18" E. This site was characterized by the absolute sovereignty of reed plant (*P. australis*) and *Ceraophyllum demersum* in the riverbed and its banks.

2.2. Physicochemical characteristics

Temperatures of water were measured immediately in the field using a precise mercury thermometer (range 10 to 60 °C). The electrical conductivity (EC) and the concentration of ion (pH) were determined using EC and pH meters. The expression of results was µS/cm for electrical conductivity (EC). Physicochemical factors were calculated such as NO_3 and PO_4 according to the standard methods (APHA, 1989; APHA, 1999).

2.3. Collection of river algae

The fresh samples of freshwater were collected from 0.3 m depth on November 2017 from all the studies sites. Using vertical hauls in each location were achieved to collect the samples of phytoplankton using plankton a net with a pore of 20 µm. All samples were individually poured into dark bottles to keep them alive, and transferred to the Lab. Subsamples were taken into objective slides for microscopic analysis.

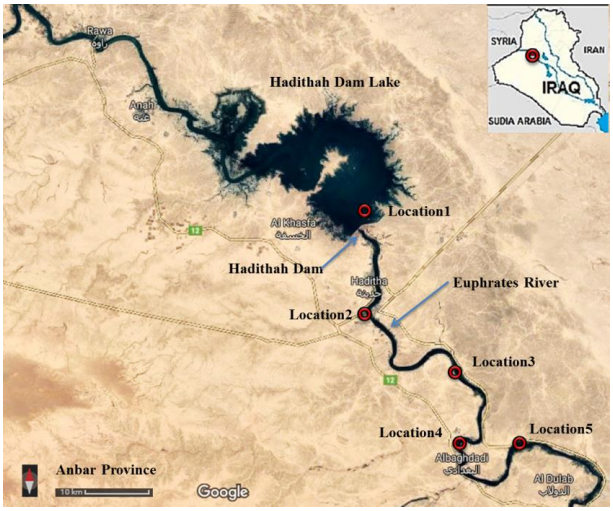

Figure 1. Map of locations of the study

2.4. Identification of algae

The prepared slides were examined using 40X to identify the algae and photographed using the microscope equipped with a camera (Olympus-CH). Identification of freshwater algae was carried out according to keys of identification in atlas of Desikachary, 1959, Prescott, 1973, and Bellinger and Sigee, 2010.

3. Results and Discussion

The physicochemical parameters were achieved in this study viz., the temperature of water, pH, electrical conductivity (EC), salinity, and the concentration of NO_3 and concentration of PO_4 as shown in Table 1. The temperature of water ranged from 18-24 ˚C in the studies sites in November 2017 that agree with weather state in this month (Al-Gaff, 2016). However, Al-Khasafa district (location 1) recorded the highest temperature (24 ˚C) while Hadithah district (location 2) recorded the lowest (18 ˚C). The concentration of hydrogen ion (pH) was slightly alkaline which ranged from 7.51-8.30 that belongs to $CaCO_3$ in sedimentations of inflows that agree with the results of (Rabee, 2007). EC and salinity of river water were approx. 800.6 µS/cm and 0.44‰, respectively. Concentrations of NO_3 and PO_4 were at average 42.4 mg/l and 5.20 mg/l respectively. The changing in physicochemical characteristics of water may belong to different species of algae in a location to another in Euphrates River (Table 1). Physicochemical parameters of water show that they are among the standard specifications of river water according to the World Health Organization (WHO) standards. This confirms that the water is not polluted, which has contributed to its biodiversity because phytoplankton are sensitive to environmental variations. For this reason, physicochemical parameters are commented couple with biological approaches existence of some organisms or disappearance can show long-term changes in water quality (Çiçek & Yamuc, 2017). The quality of water may have helped grow new species in the river. The water of the Euphrates River in the sampling sites is not contaminated as compared to the standards of the World Health Organization (WHO). Table 1 shows that the nitrate is

Table 1. Physicochemical factors of the study sites

Parameters	Locations of the study					
	Location1	Location2	Location3	Location4	Location5	Average
Temperature (˚C)	24	18	21	23	20	21.2
pH	8.30	8.00	7.51	7.74	7.90	7.89
EC (µS/cm)	935	911	662	743	752	800.6
Sal. (‰)	0.62	0.50	0.32	0.41	0.37	0.44
NO_3 (mg/l)	47	32	65	42	26	42.4
PO_4 (mg/l)	5.91	4.25	8.00	4.72	3.13	5.20
(BOD_5) (mg/l)	1.94	1.77	2.21	1.45	1.82	1.84

not excessing 50 mg/L except in the site 3, which has 65 mg/L. Also, no exceeding in the temperature of water 25 °C and its pH is not exceeding what is allowed by the parameters of the calibrators which determined by WHO set at 6.5 to 8.5 (WHO, 1996).

Rabee (2007) confirmed that the water of the Euphrates River in this area is clean and well ventilated and does not suffer from the organic pollution. All the physical and chemical properties of this river in this area are within the standards, which encouraged the occurrence of biodiversity. Also, the value of BOD (biological oxygen demand) in this study did not exceed 2.21 mg/L as in Table 1, which is comparable to the value established by Rabee (2007), who gave a value of 3.5 mg/L in his study. However, Hynes (1972) indicated that rivers with values less than 5 mg/L are clean and free from the organic pollution.

The high nitrate-nitrogen concentrations related with shallow ground water (Spruill, Eimers, & Morey, 1997). The high nitrate concentration in the river water is mainly from irrigation runoff from agriculture fields, where chemical fertilizers have been used intensively. Excess nutrients cause a massive increase in the growth of algae or plankton that overwhelms huge area of the river. As a result, the water-course choked with organic substances and organisms, consequently, the water become deficient of oxygen, which will affect the aquatic life (Al Bomola, 2011).

As the annual bulletin of the Iraqi Ministry of Environment for 2017 showed that the Water Quality Index (WQI) of the Euphrates River in Anbar province (the place of study) gave a value of 79. This means that the water is classified as clean water, as this coefficient is determined by values (1-100). The higher value of WQI means that quality of the water is best, but if it declines that indicates the poor water. This confirms the cleanliness of water in this area of the Euphrates River inside Iraq, and this is the results of the water analysis in this study as in the Table 1.

In this screening, for the first time, new seven species of algae were collected, characterized and identified in the Iraqi aquatic environments. They were found within five sites selected for this study as shown in Table 2. These species of new algal undiagnosed by other local studies, reports and checklist of algae of Maulood, Fikrat, Ali, Janan and Abbas (2013). Five genera belongs to three families namely Chloro-phyceae, Euglenophyceae and Xanthophyceae were diagnosed in Anbar province. In Table 2, *Oocystis apicurvata* was identified in three sites are Al-Khasafa, Hadithah, Al-Haqlaniya districts (locations of 1, 2, and 3) because the temperature and turbidity of the water at these sites correspond to the appropriate conditions to be coccoid of this species (Ramos, Bicudo, & Moura, 2015). *Stipitococcus* sp. was identified at the genes level which belongs to the family of Xanthophyceae. Only six species were identified at the species level, which belong to two families, Chlorophyceae and Euglenophyceae viz., *Characium debaryanum*, *Characium gracilipes*, *Chlamydomonas cienkowskii*, *Oocystis apicurvata*, *Phacus acuminatus* var. *drezoolskii*, and *Monomorphina pseudonordstedtii*.

Table 2. The newly algal species in the study sites

Family	Genes	Species	Locations
Chlorophyceae	*Characium*	*Characium debaryanum*	2
		Characium gracilipes	2
	Chlamydomonas	*Chlamydomonas cienkowskii*	5
	Oocystis	*Oocystis apicurvata*	1,2,3
Euglenophyceae	*Phacus*	*Phacus acuminatus* var. *drezoolskii*	5
		Monomorphina pseudonordstedtii	4
Xanthophyceae	*Stipitococcus*	*Stipitococcus* sp.	3

3.1 Characium debaryanum

Cells of this species, *Characium debaryanum***,** are ovoid, broadly rounded anteriorly, narrowed below into a thick stipe placed on a basal adhesive disc (Figure 2). Size of cells ranged 20-25 µm in diameter, and 30-40 µm in length (Prescott, 1973).

Division: Chlorophyta
Class: Chlorophyceae
Order: Sphaeropleales
Family: Characiaceae
Genus: *Characium*
Species: *Characium debaryanum* (Reinsch) DeToni 1889

3.2 Characium gracilipes

Cells of *C. gracilipes* are elongated cylindrical shapes, straight to very slightly curved, abruptly tapering anteriorly and extended to form a long (Figure 3). It is like a

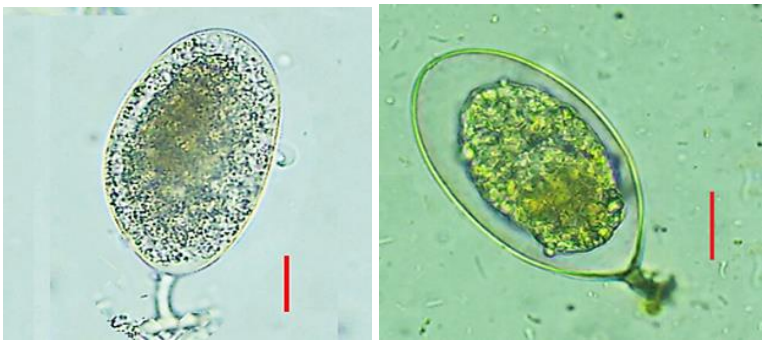

Figure 2. *Characium debaryanum* (Scale 10 µm)

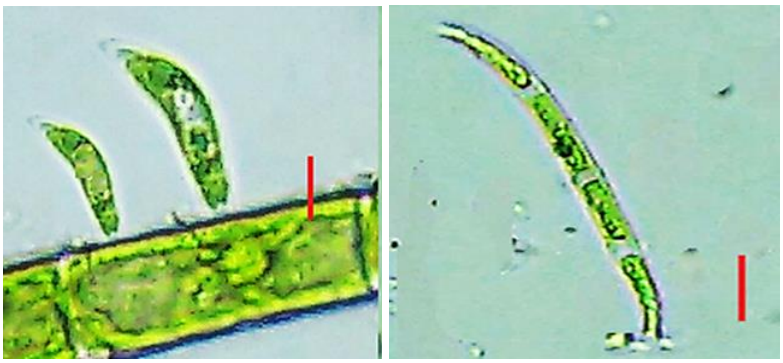

Figure 3. *Characium gracilipes* (Scale 10 µm)

hyaline hair, and it has rhizoidal branching at the base. The diameters of cells ranged 5-14 µm (Prescott, 1973).

Division: Chlorophyta
Class: Chlorophyceae
Order: Sphaeropleales
Family: Characiaceae
Genus: *Characium*
Species: *Characium gracilipes* Lambert 1909

3.3 Chlamydomonas cienkowskii

The cell of *C. cienkowskii* is cylindric with an apparent apical papilla with contractile vacuoles interiorly as in Figure 4. It has a shorter flagellum compared with the length of the cell. Its chloroplast is thin, parietal, cylindrical cup with several, pyrenoids. Pigment-spot is anterior and lateral. The diameter of cells is ranging 10-11 µm, and its length is from 20-25 µm (Whitton, John, Kelly & Haworth, 2003).

Division: Chlorophyta
Class: Chlorophyceae
Order: Chlamydomonadales
Family: Chlamydomonadaceae
Genus: *Chlamydomonas*
Species: *Chlamydomonas cienkowskii* Schmidle 1903

3.4 Oocystis apicurvata

In Figure 5, cells of *O. apicurvata* are ellipsoid with a slight median constriction and comparatively broader cells with a small pole thickening and sub-acute apices with a polar

Figure 4. *Chlamydomonas cienkowskii* (Scale 10 µm)

nodule. It has broadly rounded to slightly acute. Chloroplast of this species is usually large parietal with lobed margins, and occasionally polygonal when densely grouped. *Oocystis apicurvata* differs from all other *Oocystis* species by having ellipsoid curved cells and ellipsoidal to ovoid coenobia with oppositely curved and markedly projected polar thickenings (Tsarenko & John, 2011).

Division: Chlorophyta
Class: Trebouxiophyceae
Order: Chlorellales
Family: Oocystaceae
Genus: *Oocystis*
Species: *Oocystis apicurvata* (Ramos, Bicudo, & Moura, 2015)

3.5 Phacus acuminatus var. *drezoolskii* (Scale 10 µm)

In Figure 6, cells of *P. acuminatus* var. *drezoolskii* are green, solitary, flattened, ovoid; anterior end, rounded,

Figure 5. *Oocystis apicurvata* (Scale 10 µm)

Figure 6. *Phacus acuminatus* var. *drezoolskii* (Scale 10 µm)

posterior end wide and ending with a conical, short tail, paramylon bodies two large discs. The diameter of cells is 10-15 µm, and length of cells is 21-24 µm (Confort, 1994).

Division: Euglenophyta
Class: Euglenophyceae
Order: Euglenales
Family: Euglenacea
Genus: *Phacus*
Species: *Phacus acuminatus*
Phacus acuminatus var. *drezoolskii* Skvortzov 1928

3.6 Monomorphina pseudonordstedtii

Cells of *M. pseudonordstedtii* are napiform, nearly spherical but with a long, straight, sharply pointed caudus; broadly rounded anteriorly periplast forming an envelope widely separated from an elliptical protoplast, the periplast spirally striated; paramylon bodies not observed; chloroplasts numerous, ovoid indistinct discs, as shown in Figure 7. Size of cells is approx. 19 µm in diameter and 36 µm in length (Marin, Palm, Klingberg & Melkonian, 2003).

Division: Euglenophyta
Class: Euglenophyceae
Order: Euglenales
Family: Euglenaceae
Genus: *Monomorphina*
Species: *Monomorphina pseudonordstedtii* (Poch mann) (Marin, Palm, Klingberg & Melkonian, 2003).

3.7 Stipitococcus sp.

In Figure 8, lorica of *Stipitococcus* sp. is broadly flask-shaped, attenuated anteriorly to form a short wide neck

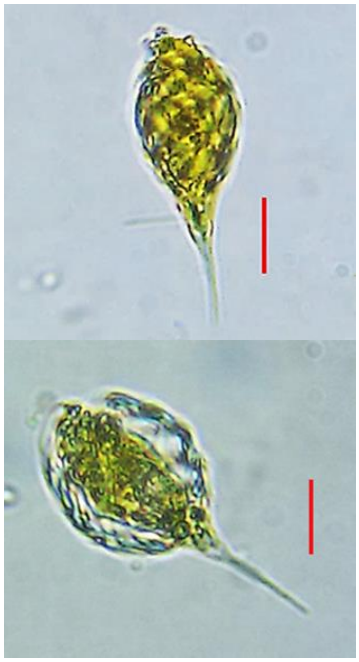

Figure 7. *Monomorphina pseudonordstedtii* (Scale 10 µm)

and reduced posteriorly into a thick stipe which is 1.5-2.0 µm wide. Its protoplast is ovoid to subglobose with two laminate chromatophores. The diameter of lorica is 7.6-8.0 µm, and the length is 18-20 µm (Al-Hussieny, 2017b).

Division: Ochrophyta
Class: Xanthophyceae
Order: Rhizochloridales
Family: Stipitococcaeae
Genus: *Stipitococcus*
Species: *Stipitococcus* sp.

Finally, according to study of Al-Gaff (2016), the diversity in the number of genera and species in the Euphrates River can be attributed to the fact that it is generally low pollution, in addition to being poor or medium-level environments in nutrients (oligo-mesotrophic water). If the levels of nutrients are increasing and taking place enrichment of Eutrophication phenomenon, the algal blooms of specific species lead to a reduction in biodiversity of other species due to competitive pressure. The less pollution and nutrients lead to the smaller the number of algae and the greater the diversity in them. Thus, the algae in water can use as indicators to the

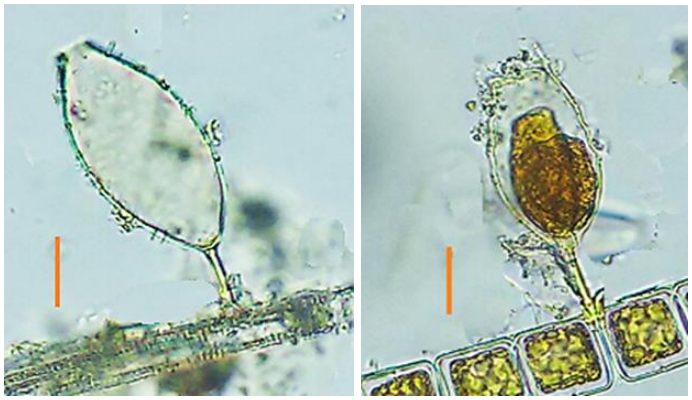

Figure 8. *Stipitococcus* sp. (Scale 10 µm)

pollution of water. The presence of small numbers of individuals with large numbers of species and the decrease in biomass is evidence of the cleanliness of the water body and vice versa.

4. Conclusions

Many samples were collected from five sites located on both sides of Euphrates River and Hadithah Reservoir in Anbar province in November 2017. About seven new freshwater algae were determined for the first time in Iraq. Of five genera, seven phytoplankton species were identified. *Characium debaryanum*, *Characium gracilipes*, *Chlamydomonas cienkowskii* and *Oocystis apicurvata* belong to Chlorophyta, while *Phacus acuminatus* var. *drezoolskii* and *Monomorphina pseudonordstedtii* belong to Euglenophyta. This work is considered the first record of new river algae in Iraq. Thus, this study has been added new data about the biodiversity of phytoplankton of Euphrates River in Iraq.

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