



IMPACT OF WATER MIXING AREAS IN QUALITATIVE VARIATIONS OF PHYTOPLANKTON ALGAE AND SOME PHYSIOCHEMICAL CHARACTERISTICS OF WATER ON A SECTION OF TIGRIS RIVER, IRAQ

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Abstract

Water mixing area between agricultural drainage represented by the water of the Tharthar Arm project and Tigris River water was studied for one year beginning from March 2015 – February 2016, water samples were taken for the purpose of diagnosing of the planktonic non –diatoms algae and measuring some physiochemical characteristic monthly from two stations after the confluence to know the impact of this mixing on biodiversity of algae community and water characteristics that affect diversity. 27 species of non-diatoms algae which belong to different divisions were identified and the study also recorded a new species for Iraqi flora *Lepocinclis salina* Fritsch belonged to Division: Euglenophyta. Results also showed that temperature of water and Air ranged (11.20- 30.80 and 7.60-36.25°C), pH (6.85-7.79) total hardness and alkalinity (314- 640 and 72-150) mg/l, DO and BOD₅ (2.30- 9.06 and 0.03- 4.53). Either the nutrients NO₃, PO₄ and SO₄ recorded the values (0.30-0.061, 1.02–1.005 and 187-702) mg/l respectively. The results also confirmed that the water of the study area was characterized by high values of conductivity, which ranged (1178-1455) *ms/cm*.

Key words: Phytoplankton, Tigris river, Tharthar Arm, New species, Mixing water.

Introduction

Iraq has great water abundance, such as the Tigris and Euphrates rivers and their tributaries, which have led to the emergence of ancient civilizations, and these two rivers are still the lifeblood of the Iraqi environment. Any disruption or mistreatment of these rivers is also largely reflected in all aspects of life in Iraq (Al-Fahad and Abbas, 2011). During its course, before entering the city of Baghdad, the Tigris River is exposed to many sources of pollution, most of which are human activities consisting of household waste and heavy water as well as water from the drainage of farmland, some plant residues and small plants on both sides of the river. Additionally, having some tributaries that increase of outstanding materials and increase in the concentration of ions and salts (Al-Magdamy, 2016).

These contaminants and various additions have led to a significant change in the chemical and physical properties of the river water, which significantly affects various neighborhoods aquatic and especially phytoplankton which are the base of the food chain in the aquatic environment (Al-Magdamy and Salman, 2015). That this change has led to the darkness of a group of algae-tolerant and one who could not resist,

and it has also helped to emerge new algae species to the environment as a result of a single or more of the changing factors in river water that has been confirmed by many researchers (Al-Magdamy *et al.*, 2017). As the salts increase after mixing the water of the Tharthar arm of the Tigris River and the presence of many contaminants has helped to provide a favourable environment for the growth and spread of a range of floating algae adapted to this situation.

Materials and Methods

The area of study in a section of the Tigris River north of Baghdad was specifically between the Tharthar arm and the Muthanna Bridge area. The site was selected by using a GPS device with longitude 44 18 26.52 and latitude 33 25 43.69 north of Baghdad. This section is characterized by the mixing of the water of Tharthar arm in the river Tigris and the slow of the flow and intensity the cane plant on the two sides, the presence of orchards, vegetable plantations, and some small factories on either side of the river. The river is exposed to many sources of pollution originating from various human activities, such as household waste, animal litter and heavy water, and these contaminants reach the river for months of year (Figure 1)

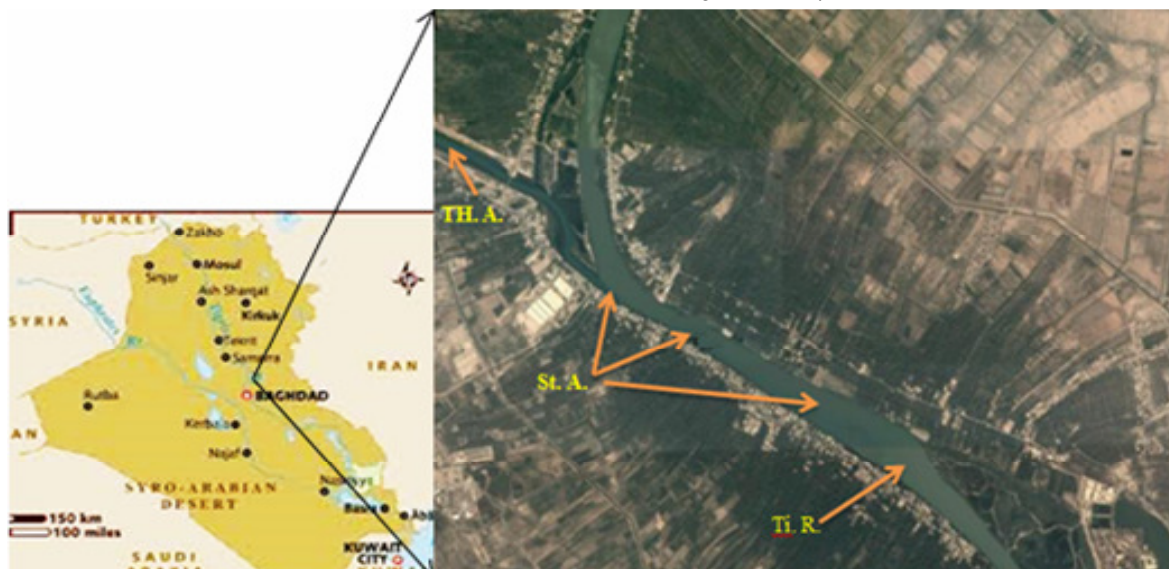


Figure 1 : Tigris River section and study application areas
 TH.A. : Tharthar arm, St. A.; Study application areas, Ti. R. : Tigris river

Collection of Samples

The water samples were collected monthly from March 2015 to February 2016 from the surface layer and 30 cm depth. Some water characteristics were measured depending on Golterman, *et al.* (1978) and APHA (2005). The samples of the floating algae were collected by using a special net with a diameter of 20 μm . The net binds with the boat and left beneath the water reversed the current for a quarter of an hour and then lifted it vertically and washed a few times with the water of the river and washed its contents a container of polyethylene, which capacity 250 ml and was preserved by Lugol's solution.

The species of floating algae have been diagnosed by preparing temporary algae slides (APHA, 2005). These slides were examined in light microscope by

using magnified bower 100x, 400x, 1000x and was adopted in the diagnosis of algae on some global and local references, Nural-Islam and Nahar (1969); Prescott (1982), Nural-Islam and Haroon (1985).

Results and Discussion

The results of the study factors indicated that there were clear changes between the different months of the year (Table 1), as the region's climate was characterized as hot and dry in summer while cold and rainy winter. This effect applies to the rest of the environmental variables considered as the percentage of dissolved oxygen in water and bio demined for oxygen and other variables that have to relate with temperature change (Al-Janabi, 2011).

Table 1: Some physiochemical properties of the Tigris River waters within the study area.

Parameters	Months												Mean
	2015						2016						
	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Des.	Jan.	Feb.	
Air temperature	13.48	25.55	33.94	30.43	32.50	36.25	35.90	23.10	22.85	15.47	7.60	14.74	24.32
Water temperature	16.65	20.50	25.50	28.58	30.05	29.95	30.65	25.05	19.45	15.85	11.80	13.40	22.31
pH	7.18	7.35	7.54	7.58	7.56	7.61	7.70	7.38	6.92	7.12	7.23	6.89	7.34
Ec $\mu\text{s.cm}^{-1}$	1157	1040	1149	1443	1246	1069	1954	1512	1762	1449	1816	1386	1415
T. Alkalinity	139	148	132	93	100	104	79	80	74	104	124	112	107.42
T. hardness mg/l	448	315	364	507	426	372	456	526	620	497	318	599	454
DO mg/l	6.90	5.00	5.12	2.43	2.40	2.45	2.41	3.20	3.00	2.85	8.66	8.97	4.45
BOD ₅ mg/l	4.44	2.74	1.10	1.34	1.00	0.45	0.32	0.70	0.70	0.07	1.37	2.87	1.51
NO ₃ mg/l	0.97	0.70	0.74	0.31	0.39	0.44	0.41	0.48	0.48	0.62	0.97	0.76	0.60
PO ₄ mg/l	0.78	0.30	0.52	0.43	0.75	0.73	0.24	0.07	0.26	0.15	0.27	0.49	0.42
SO ₄ mg/l	300	170	218	409	360	246	252	455	570	586	210	377	345.42

The temperature was characterized by a gradual rise during June, July, August and September as well as decreases during January and February. The air temperature ranged from 7.60-36.25°C and affected by water temperature ranging between 11.80-30.65°C, while the pH ranged from 6.89-7.70. The water was characterized by alkalinity, pH increased in February and November because of the impact of the river on household residues, hypothermia, lack of organic decay and the lack of water plants and phytoplankton (Abowei and George, 2009; Al-Saadi, 2013). The values of conductivity arranged from 1040-1816 mg/L and the total hardness ranged from 315-599 mg/L. The increase of these two factors in the studied site is due to the increase in the salt from the water added to the river from the Tharthar arm, which brings the water from the Euphrates River and the Tharthar had highly concentration of the salts compared with the Tigris River (Zeidan *et al.*, 2009).

The height of the hardness may also be due to the impact of human activity, sewage and industrial water to the river and soil texture, which is agree with Al-Lami (2002) and this confirms by Safawi (2007). Alkalinity values increase in spring months and gradually decrease in winter months, autumn and summer, ranging from 74 to 148 mg/L. The increase is due to the rise in water caused by rainfall and low temperatures, which increase the dissolution of carbon dioxide in water and thus increase the Alkalinity (Smith, 2004). This is agreeing with Al-Shandah (2008). Dissolved oxygen values fluctuated between 2.40-8.97 mg/L that it increases in cold months and decreases with gradual temperature rises and this is consistent with Al-Asadi (2015) this indicates an increase in organic degradation and the

consumption of oxygen micro-organisms and a high concentration of organic matter and salts in the waters which in turn act on consumption of DO chemically (McNeely *et al.*, 1979; Moore *et al.*, 2004; Shukri *et al.*, 2011).

The BOD values of 0.07-4.44 mg/L were characterized by a change between the months and were not dependent on the change in temperature only, but were affected by what was thrown into the river of environmental and organic materials, the quality and quantity of microorganisms that are increasing when the rains are falling and pH values change, and the evidence increases the values of this factor in the cold winter months, this agrees with Hem (1985) and Hamad and Salman (2013).

Nutrient values ranged from (0.31-0.97, 0.07-0.78, 170-586) mg/L for nitrate, phosphate and sulphate respectively, where plant nutrient values increase in months of winter and spring and goes down in the summer and autumn months and this is mainly due to increased water levels and falling rainfall and the residues of agricultural fertilizers are washed out of the land adjacent to the river as well as the presence of the animal manure (Al-Tamimi, 2006).

Biological Study

The present study enabled the diagnosis of a group of algae, which was marked by its presence throughout the study period. 27 taxonomic units were recorded belong to sixteen genus the dormancy of the Chlorophyta and Cyanophyta (12 species of each other's) followed by the Euglenophyta algae (two species) and one type of Pyrrophyta, Algae as one new species added to the Iraqi list, (Table 2).

Table 2 : Species of phytoplankton were recognized in month study

Taxon	Months											
	2015						2016					
	3	4	5	6	7	8	9	10	11	12	1	2.
<i>Botryococcus braunii</i> Kuetzing	+	+	+	+	+	-	--	-	-	-	+	+
<i>Chroococcus limneticus</i> Lemmermann	+	+	+	-	-	-	-	-	-	+	+	-
<i>Chroococcus turgidus</i> (Kuetz.) Naegeli	-	+	+	+	+	+	+	+	+	-	-	-
<i>Cosmarium speciosum</i> Lund.	+	-	-	-	-	-	-	+	+	+	+	+
<i>Crucigenia fenestrata</i> Schmidle	-	-	+	+	+	-	+	+	+	+	-	-
<i>Crucigenia tetrapedia</i> (Kirchner) West And West	+	+	-	+	+	+	+	-	-	+	+	-
<i>Glenodinium quadridens</i> (Stein) Schiller	+	+	+	+	-	+	+	+	-	+	+	+
<i>Lepocinlis playfairiana</i> Deflandre	-	+	+	-	-	+	+	-	+	+	+	-
<i>Lepocinlis salina</i> Fritsch	-	-	-	+	+	+	+	+	+	-	-	-
<i>Lyngbya martensiana</i> Meneghini.	+	+	+	+	+	+	+	+	-	-	-	-
<i>Merismopedia elegans</i> A. Braun	-	-	+	+	+	+	+	+	-	-	-	-
<i>Merismopedia minima</i>	+	+	-	-	-	-	--	+	+	+	-	-
<i>Nostoc</i> sp.	+	+	-	-	-	+	+	+	+	+	-	-
<i>Oocystis borgei</i> Snow	+	+	+	+	-	-	-	-	-	+	+	+

<i>Oscillatoria Formosa</i> Bory.	+	+	+	+	+	+	+	-	-	+	+	-
<i>Oscillatoria limnetica</i> Lemmermann.	-	+	+	+	+	+	-	-	-	-	+	+
<i>Oscillatoria lacustris</i> (Kleb.)Geitler.	+	+	+	+	+	+	+	+	-	-	+	-
<i>Oscillatoria sancta</i> (Kuetz)Gomont.	+	+	+	+	+	+	+	+	+	-	-	-
<i>Oscillatoria prolifica</i> (Grev.)Gomont	+	+	-	-	-	-	-	+	+	+	+	+
<i>Pediastrum simplex</i> var. <i>ctathratum</i>	+	+	-	-	-	-	+	+	+	+	+	+
<i>Pediastrum tetras</i> fa.	+	+	+	-	-	-	-	+	+	+	+	-
<i>Pediastrum duplex</i> var. <i>Reticulatum</i> Lagerhei m.	+	+	+	+	-	-	-	-	-	+	+	+
<i>Scenedesmus dimorphus</i> (Trup.) Kuetz.	+	+	-	-	-	-	-	+	+	+	+	+
<i>Scenedesmus obliquus</i> (Turp.) Kuetzing	+	+	-	-	-	-	-	-	+	+	+	+
<i>Spirulina nordstedtii</i> Gomont	-	+	-	-	-	-	-	+	+	-	-	-
<i>Tetraedron minimum</i> (A.Br.)Hans	+	+	-	-	-	+	+	+	-	-	+	-
<i>Westella botryoides</i> (W. West) de Wildeman	-	-	-	+	+	+	+	+	+	-	-	+

Cyanophyta spread of many environments marine or freshwater and soil, because of exhibiting a high level of adaptability to different environments, as well as ability to adapt for unfavorable environmental conditions Cyanobacteria could contribute to bioremediation of polluted areas (Radha *et al.*, 2014).

Describe some species that recorded of the months study

Division : Chlorophyta
Class : Chlorophyceae
Order : Chlorococcales
Family : Botryococcaceae
Genus : *Botryococcus braunii* Kuetzing

(Fig.1 ,Pl. 1) (Prescot, 1982, Pl.52, Figs. 1,2,11)

Cells elliposoid, radiately arranged at the periphery of irregularly shaped usually dark-colored masses of mucilage; free floating; colonial mucilage much folded and extended in to touch, foamy strand, often forming colonial complexes by interconnecting strands of mucilage; chloroplast a thin, or dense, parietal net with 1 pyrenoid, covering only a portion of the wall; starch and oil droplets present, individual cells invested by a layer of fatty substance and an outer layer of pectin, cells 3-6 μ in diameter 6-12 μ long. Common and often abundant, especially in semi-hard water lakes.

Division : Chlorophyta
Class : Chlorophyceae
Order : Chlorococcales
Family : Dictyosphaeriaceae
Genus : *Westella botryoides*

(W. West) de Wildeman (Fig. 2, Pl. 1)
(Nural-Islam and Begum, 1970, Pl. 4, Figs. 102-103; Prescot, 1982, Pl. 53, Figs. 14)

Cells spherical and grouped in fours: loose colony; groups are held together by the remnant of the gelatinous mothers membrane; 4.8-7.7 in diam., colony 15.4-39.6 μ in diam., found in Mirpur Majar pond, ditch near Kamalapur and Aga Mosih Lane mosque tank from April to November.

Division : Chlorophyta
Class : Chlorophyceae
Order : Chlorococcales
Family : Oocystaceae
Genus : *Crucigenia fenestrata* Schmidle

(Fig. 3, Pl.1) (Prescot, 1982, Pl.65, Fig. 5, p. 284; Nural-Islam and Begum,1970, Pl. 4, Fig. 112.)

Colony of a 4 cells, arranges about a square opening; colony 8.8-17.6 μ wide and 11-19.8 μ long; cells 2.2-5.5 μ in diam., 4.4-6.6 μ long; found in D.U. Bot. garden reservoir in April and May.

Division : Chlorophyta
Class : Chlorophyceae
Order : Chlorococcales
Family : Oocystaceae
Genus : *Oocystis borgei* Snow (Fig.4 ,Pl.1)

(Nural-Islam and Khatun, 1966, Pl. 4, Figs. 99-102; Prescot, 1982, Pl.51, Fig. 10, p. 243; Olenina *et al.*, 2006)

Unicellular or crowded in groups of 2-8, in closed by the old mother cell wall ;ellipsoid or ovate cells with the poles broadly rounded and smooth; chloroplast 1 or as many as 4 parietal plates, each with a pyrenoid, cells (9)-10-19 μ long, colony of 8 cells, up to 31 μ in diameter, 46 μ long .

Division : Chlorophyta
Class : Chlorophyceae
Order : Chlorococcales
Family : Oocystaceae
Genus : *Pediastrum*
Species : *Pediastrum duplex* var. *reticulatum*

Lagerheim. (Fig. 5 , Pl. 1)
(Nural-Islam and Begum, 1970, Pl. 7, Figs. 222-223; Nural-Islam and Zaman,1975, Pl. 3, Figs. 23; Prescot,1982, Pl. 49, Fig.1, p.224)

Outer margins of the peripheral cells having lobes with sub-parallel sides; inner cells nearly H-shaped; outer cells 4.4-15.4 μ wide, 8.8-19.8 μ long; inner 2.3-17.6 μ wide, 6.6-17.6 μ long; found in high court pond,

Gandaria mosque tank and D.U. Bot. garden reservoir in April and June.

Genus : *Pediastrum*
Species : *Pediastrum simplex* var. *ctathratum*.
(Fig. 6, Pl. 1)

(Nural-Islam and Begum, 1970, Pl. 7, Fig. 226; Pl. 8, Fig. 228; Nural-Islam and Zaman, 1975, Pl. 3, Figs. 25, 26, 30)

Coenobium 8-32 celled; cells more deeply emarginated and perforation larger and oval-round; inner cells 8.8-13.2 μ wide, 11-14.3 μ long; peripheral cells 6.6-14.3 μ wide, 19.8-24.2 μ long; found in pond in Zinzira, Narinde bridge mosque tank, Ram-Krishana Mission Road mosque tank in May, November and December.

Genus : *Pediastrum*
Species : *Pediastrum tetras* fa. (Fig.7, Pl.1)

(Nural-Islam and Begum, 1970, Pl. 8, Fig. 238; Prescott, 1982, Pl.50, Fig.3, 6, p. 227)

The peripheral cells are furnished with long bilobed processes; cells 6.6 μ in diam.; 7.7 μ long; found in secretariat mosque tank in June.

Division : Chlorophyta
Class : Chlorophyceae
Order : Chlorococcales
Family : Oocystaceae
Genus : *Scenedesmus*
Species : *Scenedesmus dimorphus* (Trup.)
Kuetz. (Fig. 8, Pl.)

(Nural-Islam and Begum, 1970, Pl. 5, Figs. 162-168; Prescott, 1982, Pl. 63, Fig. 8, 9, p. 277)

Colony of 4 or 8 fusiform cells, arranges in a single or al-ternate series; cells 2.2-6.6 μ wide and 11-22 μ long; very common and found in high court pond D.U. Bot. garden reservoir, Mirpur Majar pond and many other ditches and ponds all through out the year.

Genus : *Scenedesmus*
Species : *Scenedesmus obliquus* (Turp.)
Kuetzing. (Fig. 9, Pl.)

(Nural-Islam and Begum, 1970, Pl. 5, Figs. 180-184; Prescott, 1982, Pl. 63, Fig. 17, p. 229)

Colony of 2-8 fusiform cells with abruptly tapering ends, wall smooth; cells 2.2-4.4 μ in diam., 11-22 μ long; found in D. U. Bot. garden reservoir, high court pond, Dhanmondi lake, Ramna lake and many others almost all throughout the year.

Division : Chlorophyta
Class : Chlorophyceae
Order : Chlorococcales
Family : Oocystaceae
Genus : *Tetraedron minimum*
(A.Br.) Hans. (Fig.10, Pl.)

Nural-Islam and Begum, 1970, Pl.1, Fig.11-12. p.234, p.256; Prescott, 1982, Pl.60, Fig. 12-15 , p. 267)

Cell small, flat, tetragonal, lobes sometimes cruciately arranged, 6.4-8.8 μ in diam.; young cells 4.4-6.6 μ in diam.

Division : Euglenophyta
Class : Euglenophyceae
Order : Euglenales
Family : Euglenaceae
Genus : *Lepocinclis*
Species : *Lepocinclis playfairiana*
Deflandre (Fig. 11, Pl.)
(Prescott, 1982, p. 227 Pl.89. Fig. 16)

Cells broadly oval with a short caudus, slightly narrowed and sharply rounded anteriorly, the gullet and flagellum attachment lateral to the apex, where there is a slight invagination on the right side; periplast smooth; paramylon bodies 2 large circular or oval rings; cells 28-30 μ in diameter, 46-48 μ long.

*Species: *Lepocinclis salina* Fritsch. (Fig. 12, Pl. 1)
New Record

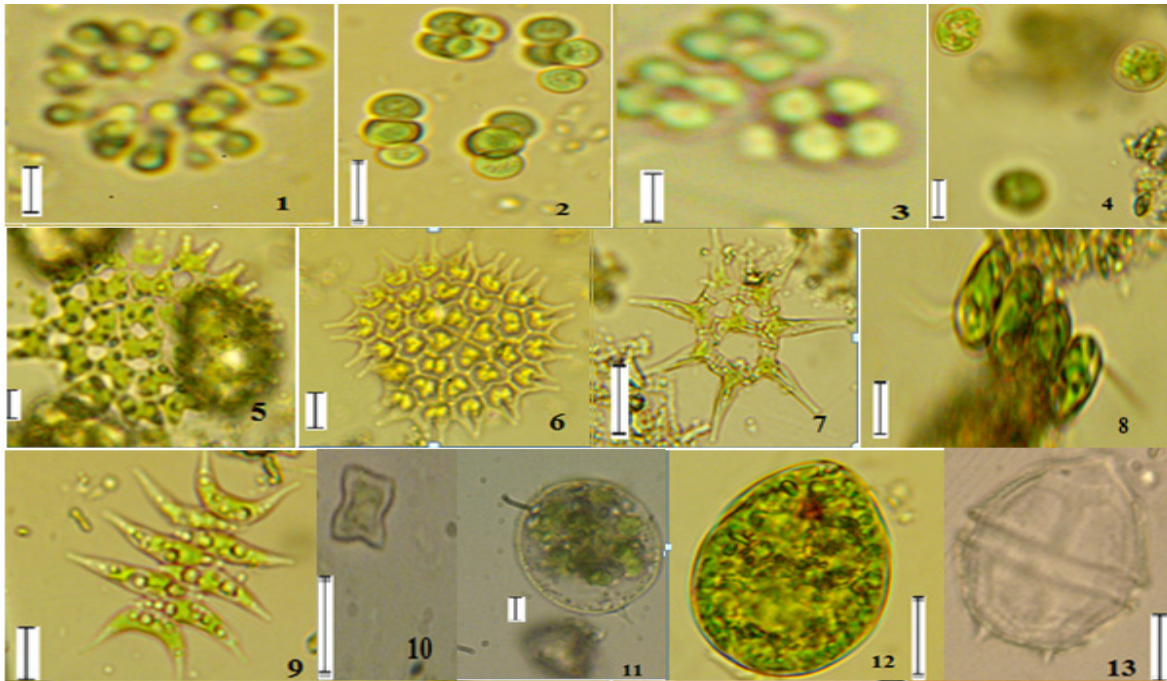
(Huber-Pestalozzi 1955, 157, 32: 173; Ling and Tyler 2000, 79, 37: 11)

(*New record in Iraq according to Maulood *et al.* 2013)
Cells ellipsoid to ovoid, anterior end comparatively narrowed than posterior. Mouth meaningfully ex-central. Posterior end broadly rounded, no caudus. Periplast spirally striated. Chloroplasts discoid, many. Flagellum 10.6-40.0 μ m long. Paramylon round, grains, never ring like. Cells 31-38 μ m long, 23-31 μ m broad.

Division : Pyrrophyta
Class : Dinophyceae
Order : Peridinales
Family : Glenodiniaceae
Genus : *Glenodinium quadridens* (Stein)
Schiller. (Fig. 13, Pl. 1)

Prescott, 1982, Pl. 90, Figs. 19, 20, p. 430).

Cells ovate, the epiconeapiculate, the hypocone broadly rounded and furnished with 3-5 short, sharp spines, laterally and posteriorly placed; transverse furrow not spiral, usually median and equally diving the cell; longitudinal furrow extending into the epicone, widening posteriorly and reaching the apex of the hypocone; epitheca with 1 apical, 5 intercalary, and 7 precingular plates; hypotheca with 5 postcingular and 2 antapical plates with a stout spine on each; cells 20-35 μ in diameter, 24-30 μ long).



Pl. 1: Phytoplankton diversity in the samples: 1-*Botryococcus braunii*, 2- *Westella botryoides*, 3- *Crucigenia fenestrata*, 4- *Oocystis borgei*, 5- *Pediastrum duplex* var. *reticulatum*, 6- *Pediastrum simplex* var. *ctathratum*, 7-*Pediastrum tetras*, 8- *Scenedesmus dimorphus*, 9- *Scenedesmus obliquus*, 10- *Tetradron minimum*, 11-*Lepocinclis playfairiana*, 12- *Lepocinclis salina*, 13- *Glenodinium quadridens* .Scale bar indicates 10 μ m

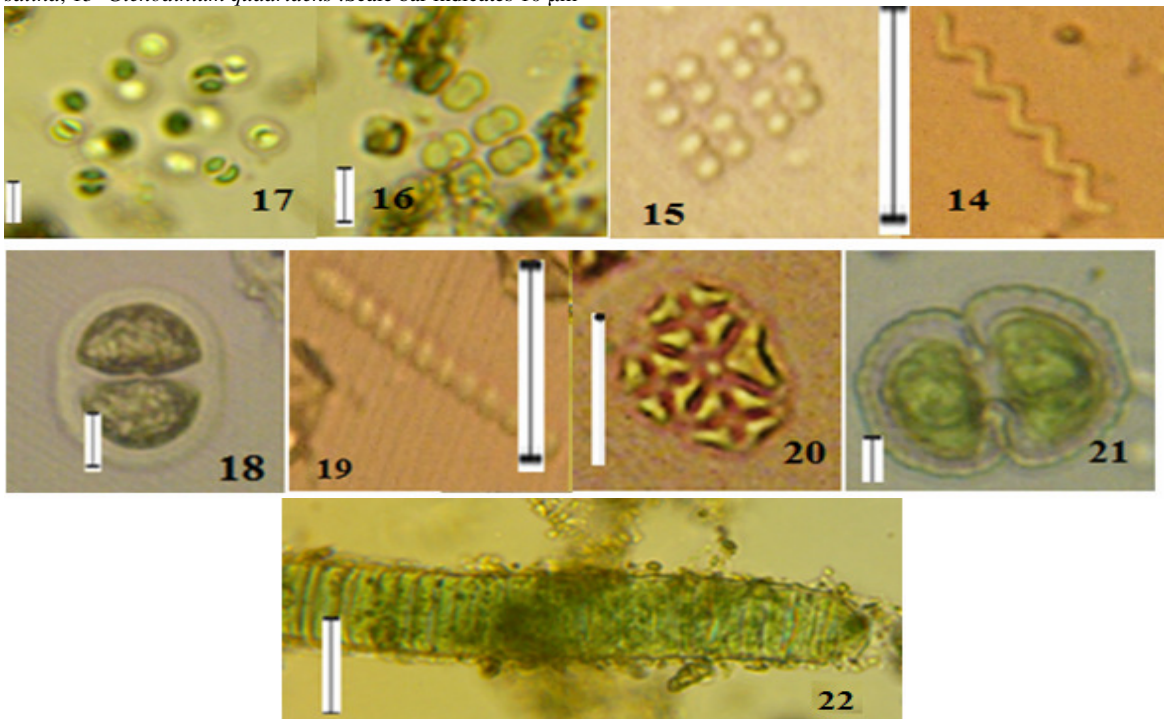


Plate 2: 14- *Spirulina nordstedtii*, 15- *Merismopedia minima*, 16- *Merismopedia elegans*, 17- *Chroococcus limneticus*, 18- *Chroococcus turgidus*, 19- *Nostoc* sp., 20- *Crucigenia tetrapedia*, 21- *Cosmarium speciosum*, 22-*Lyngbya martensiana*

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