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Systematic study of epiphytic algal after restoration of Al-Hawizah marshes, southern of Iraq

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Abstract: A study of epiphytic algae in restored marshes in Mesopotamian marshes, southern Iraq was carried out seasonally from winter 2008 to spring 2009. Four sites were selected in Al-Hawizah marshes (Um El-Wared , Um El-Na'aj , Al-Adaim and Soda north). Samples of epiphytic algae were collected from four species of host hydrophytes (Phragmites australis Trin ex, Typha domengensis Pers , Ceratophyllum demersum L. and Potamogeton pectinatus L.). In this study, five classes, twenty seven genera and fifty-five species of epiphytic algae were described. Seven species and two varieties of identified epiphytic algae in this study were new records to the flora of algae in Iraq for the first time.

Key Words: Systematic study, Epiphytic algae, Wetlands, Mesopotamian marshes

Introduction

Mesopotamian marshes in Iraq occupy a vast network of wetlands at southern region. Most of these marshes exposed to dry completely or partially during 1990s due to the ex government's policy. Various projects had been carried out on these marshes after the rehabilitation (Hamdan *et al*., 2010; Haidarey *et al*., 2010). Previous studies did not focus on the Al-Hawizah marshes in contrast to other Mesopotamian marshes (Al-Saadi *et al*., 1979; Maulood *et al*.; 1979 and Al- Mousawi *et al*., 1994). Recently a few papers on phytoplankton and primary production were published on this marshes, these projects were a contribution from the Canada-Iraq Marshlands Initiative (Al-Handal & Abdullah , 2010 and Hassan *et al*., 2011), but no studies were carried out on the benthic algae in previous works. .Mitsch & Gosselink (2000) mentioned the importance of the contributions of epiphytic algae in nontidal freshwater marshes. Other authors were explaining the ecological importance of all types of benthic algae in aquatic systems (Nozaki *et al*.,2003 and Simkha'ada *et al*., 2006). Many environmental factors effected

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the distribution, diversity and abundance of epiphytic algae on the hydrophytes in marshes; such as light, temperature, type and growth phase of host plant, depth, nutrients, etc. (Scheldon & Boylen 1975; Limpens *et al*., 2003; Michael *et al*., 2008). Some studies focused on the qualitative and quantitative changes in population dynamics of epiphytic algae on different host macrophytes in different aquatic systems (Kassim *et al*., 1997; Blindow, 1987; Kassim & Al-Saadi, 1995; Kassim *et al*., 2000; Hadi & Al-Zubaidi 2001 and Hassan *et al*., 2007). The present work aimed to study the systematic account for epiphytic algae on four species of host macrophytes in Al-Hawizah marshes and to fill the knowledge gap in epiphytic algae in marshes for the first time.

Study Area

Al-Hawizah marshes situated to the east of river Tigris, these marshes extend for about 80km from north to south and 30 km from east to west (Fig.1). A portion of these marshes (21%) extends over the border into Iranian territory and from these sites marshes is fed by Karkheh River (Iran) while the other portions fed by the river Tigris (Scott, 1995). Portions of marshes are:

Permanent Marshes are the deep open water marshes that represented the middle and east part of the study area. These marshes comprise three marshes: Um El-Nia'aj, Al-Adaim and Al-Soda North (Bedair *et al*., 2006).

Seasonally Marshes are shallow water marshes and are comprised of four marshes; Um El-Wared, Majnoon, Al- Soda south and Lissan Ejerda.

During 1990s the marsh Um El-Wared had been dried completely, while Um El-Nia'aj and Al-Soda North partially dried but the Al- Adaim had not dried. In the current study four marshes were selected (Um El-Nia'aj, Um El-Wared, Al- Adaim, and Al-Soda North) and appointed by using Geographical Positioning System (GPS). Table 1 shows the study sites positions.

Materials and Methods

Four species of host aquatic plants were collected during Winter (February , 2008) , Summer (August , 2008) , Autumn (November , 2008) ,Winter (January , 2009) , and Spring (March , 2009) . The host aquatic plants are *Phragmites australis* Trin ex, *Typha domengensis* Pers , *Ceratophyllum demersum* L. and *Potamogeton pectinatus* L. Samples were collected from under water surface due to seasonal abundance and uneven local distribution from study sites (Um El-Wared , Um El-Na'aj , Al-Adaim and Soda north) and the host plants determination was performed in the herbarium of the college of Science in the University of Baghdad. The plant parts were placed in polythene bags and kept wet for laboratory examination. Separation of epiphytic algal population from their host was carried out by scraping and manual shaking for 30 minutes (Zimba &Hopson, 1997). The epiphytic algal cells were preserved with 1 ml Lugol's solution for identification. Several references were used for identification of epiphytic non-diatoms (Desikachary, 1959; Prescott, 1979, 1982; Nurul-Islam &Khatun, 1966; Nurul-Islam &Zaman, 1975; Nurul-Islam & Haroon 1985; Hinton & Maulood 1980; Al-Handal 1995; Wehr &Sheath 2003; Skinner &Entwisle 2004; Felisberto & Rodrigues 2004 and Delazari-Barroso, *et al*., 2007). And for diatoms (Hustedt ,1930; Bourrelly ,1970; Hirano ,1973; Patrick &Riemer 1966 , 1975; Benson &Rushforth 1975; Pankow, 1976; Foged, 1978; Czarnecki & Blinn 1978 ; Germain ,1981 ; Hadi *et al*., 1984 ; Al-Zubaidi 1985; Hadi & Al-Zubaidi 1992 ; Snoeijs, 1993 ; Snoeijs &Balashova 1998).

Fig. 1: Map of the Al-Hawizah marshes, south Iraq illustrating study sites.

Table 1: Sampling sites and their location by GPS

Station	sites	Longitude (East)			Latitudes (North)		
		″	′	°	″	′	°
St.1	Um El-Wared	12.5	34	31	11.7	31	47
St.2	Um El-Na'aj	14.99	37	31	13.7	34	47
St.3	Al-Adaim	30	41	31	0	44	47
St.4	Al-Soda North	595	40	31	53	40	47

The identifications of algae were performed under Olympus microscope. Photographs were taken by compound microscope and microns (μm) are used to describe the diameter of each examined taxon. All the identified algae arranged systematically following (Smith, 1950 and Prescott, 1982). The identification references were listed beside each taxon.

Results and Discussion

In this study, four divisions, five classes, twenty eight genera and fifty- five species were identified as following:

Division A: Chlorophyta

Class: Chlorophyceae

Division B: Chrysophyta

Class: Xanthophyceae

Class: Bacillariophyceae (Diatoms)

Division C: Cyanobacteria

Class: Myxophyceae

Division D: Rhodophyta

Class: Rhodophyceae

Seven species and one variety of identified epiphytic algae in this study were added to the flora of algae in Iraq for the first time as new records according to the last check list of algae flora in Iraq (Maulood and Toma 2004). The following are a description of some identified algae in this study:

Division: Chlorophyta

Class: Chlorophyceae

Order: Oedogoniales

Family: Oedogoniaceae

Bulbochaete sp. Agardh (pl. 1, Figs. 1a,b) (Nurul-Islam 1972; Prescott 1979, 134, Fig. 221; Prescott 1982, 145).

Thallus a unilaterally branched filament arising from a basal cell which has a holdfast organ (adhesive disc or rhizoidal processes). Vegetative cells, cylindrical usually distinctly larger at the anterior end where a branch may arise; 52.5-62.5 μm long, 10-12.5 μm in diameter. Approximately all cells bear a ring a long seta with a bulbous base, arising obliquely form the anterior end of the cell. Chloroplast a parietal entire dense or loose, covering almost the entire lateral walls. Reproductive organs not found in the specimens

Epiphytic on Phragmites australis, Ceratophyllum demersum, & Potamogeton pectinatus.

Order: Chlorococcales

Family: Characiaceae

Characium ambiguum Hermann (pl. 1, Fig. 2) (Prescott 1982, 216, pl.45, Fig. 11).

Cells solitary, lance-shaped, fusiform, narrowed to sharp point anteriorly, tapering posteriorly to a fine hair-like stipe, without an attaching disc, chloroplasts 1-3; cells 7.5μm in diameter, 25μm long.

Epiphytic on Phragmites australis.

Characium ornithocephalum A. Braun (pl. 1, Fig.3) **(New record)**

(Prescott 1982, 218, pl. 48, Fig.14)

Cells broadly and unsymmetrically ellipsoid, convex on one side nearly straight on the other, abruptly narrowed interiorly to form a sharp apiculation, the cell body set at an angle and curved a way from a long stipe with a base attaching disc; chloroplast laminate, parietal with a conspicuous pyrenoid; cells 28.6 µm long, without stipe; 7.8 µm in diameter.

Epiphytic on Ceratophyllum demersum.

Order: Cladophorales

Family: Cldophoraceae

Cladophora glomerata (L.) Kützing (pl. 1, Fig. 4a,b)

Prescott 1982, 138, pl. 20, 21, Figs. 8, 9, 1, 2; Skinner & Entwisle 2004, 742, Fig. 5d.

Attached, branched filaments, forming dark green, fluffy or streaming arbuscular thalli, usually in flowing water. Filaments, regularly branched, the branches usually crowded in the upper limits. Cells very slightly attenuated toward the apices of the branches, which are bluntly pointed. Main axis 110 µm in diameters, 6-7 times the diameter in length; Cells in the branches 50 µm in diameter, 3-6 times the diameter in length.

Epiphytic on all host studied plants.

Cosmarium subtumidium Nordstedt (pl. 1, Fig. 5)

(Nurul-Islam & Zaman 1975, 53, pl.7, Figs. 98, 99; Al-Handal 1995, 96, pl.3, Fig. 27).

Cell wall smooth, long 28.6 µm, wide 26µm, wide at isthmus 9.1 µm, mid deep, sinus deep and opening to the isthmus, semicell oblong in apical view and orbicular in side view. Epiphytic on all host studied plants.

Cosmocladium sp. de Brébisson (pl.1, Fig. 6) **(New record)**

(Opute 2000, 143, pl. 6, Fig. 10; Wehr &Sheath 2003, 374, Fig.30).

Cells are essentially identical in form to some smooth-walled *Cosmarium.* Cell is biradiate with a narrow or broad isthmus that does contain one chloroplast per semicell and a central pyrenoid. The nucleus is positioned in the isthmus c between chloroplast. The cells are united into colonies by connecting strands secreted by special groups located near the base of the semicell; cells 5 µm in diameter, 8.75 µm long.

Epiphytic on Ceratophyllum demersum.

Euastrum dubium Nägeli (pl. 1, Fig. 7)

(Nurul-Islam and Haroon 1985, 882, pl.2, Fig. 39)

Cell not very flattened; semicell with three lobed, apical and two lateral lobes, apex of semicell with median incision or notch, cell 27-31.2 µm long, 12.5-20.8 µm in diameter, diameter at isthmus 5.2-6.5 µm.

Epiphytic on all host studied plants.

Order: Oedogoniales

Family: Oedogoniaceae

Oedogonium sociale Wittrock (pl. 1, Fig. 8) **(New record)**

(Prescott 1982, 174, pl. 32, Figs. 7-9)

Attached, unbranched filament. Vegetative cell 15 µm in diameter, 63-65 µm long, chloroplast a parietal reticulum with many pyrenoids. Macrandrous; dioecious, oogonia solitary; subglobose or ellipsoid-globoses, opening by a median pore; 32 µm in diameter; 42 µm long. Oospore globose or broadly ellipsoid-globose; Nearly filling the oogonia; Wall smooth; 28 µm diameter, 32 µm long, antheridia 15 µm in diameter, 10 µm long.

Epiphytic on all host studied plants.

Order: Chlorococcales

Family: Scenedesmaceae

Scenedesmus arcuatus Lemmermann (pl. 1, Fig. 9)

(Nurul-Islam & Khatun 1966, 99, pl.3, Figs. 80-81; Nurul-Islam &Begum 1970, 251, pl.5, Figs. 137-139; Pankow 1976, 378, Fig. 852; Prescott 1982, 275, pl.62, Fig. 8).

Cells arranged to form a curved (usually double) series of 4-16 oblong - ovate individual with lateral walls in contact a long 0.33 to 0.5 their length; cell wall without spines; poles of the cell broadly rounded; cells 7.5 µm in diameter, 10 µm long.

Epiphytic on all host studied plants.

Scenedesmus bijuga (Turp.) Lagerheim (pl. 1, Fig. 10)

(Nurul-Islam & Khatun 1966. 99, pl.4, Fig.86; Nurul-Islam &Begum 1970, 252, pl.5, Figs.147, 149, 150; Pankow 1976, 380, Fig. 857; Prescott 1982. 276, pl.63, Fig.2).

Colony composed of 2-4 cells in single flat series. Cells ovate or oblong, without spines, cells 4.55 µm in diameter, 13 µm long. The width of this species is less than observed by Nurul-Islam & Khatun, 1966; Prescott 1982.

Epiphytic on all host studied plants.

Spirogyra nitida (Dillw.) Link (pl. 2, Fig. 11)

(Prescott 1982, 318, pl. 73, Fig. 10)

Filaments of rather stout cells, 60 µm in diameter, and 97.5 µm long, with plane end walls; chloroplasts 3.5, making ½ to 1½ turns. Fertile cells by cylindrical, zygospores ellipsoid, or cylindrical- ellipsoid with sharply rounded poles; median spor wall smooth and brown; 57.5 µm in diameter, 92.5 µm long.

Epiphytic on all host studied plants.

Order: Zygnematales

Family: Zygnemataceae

Spirogyra scrobiculata (Stoch.) Czurda (pl. 2, Fig. 12a,b)

(Prescott 1982, 320, pl.76, Figs. 3, 4)

Unbranched, long filaments; cells of filaments cylindrical and short 22.5µm in diameter, 60.5µm long, with plane end wall; chloroplast spirally solitary, making 1-5 turns.

Conjugation by tubes from both gametangia, the fertile cells inflated on the conjugating side; zygospores ellipsoid, smooth 27.5 µm in diameter, 55.5 µm long median pore wall deeply pitted and brown.

Epiphytic on all host studied plants.

Thamniochaete sp. F. Gay (pl. 2, Fig. 13) **(New record)**

(Prescott 1979, 125, Fig. 206; Wehr & Sheath 2003, 337, Fig. 213)

Filaments are uniserate, erect system only, usually composed of a small number of irregularly cylindrical to ellipsoid or barrel-shaped, each containing a parietal chloroplast and single pyrenoids. The terminal cells and less often the cells between the terminal cells and lower most cell bear long onion-shaped setae. Vegetative cells 10-12.5 µm, 15-17.5 µm in diameter.

Epiphytic on Phragmites australis & Potamogeton pectinatus.

Division: Rhodophyta

Class: Rhodophyceae

Compsopogon sp. Mantagne (pl. 2, Fig. 14)

(Prescott 1969, 248, pl.17, Fig. 239; Prescott 1979, 139, Fig. 230).

This freshwater, branched, filamentous genus grow in flowing water, and is usually epiphytic. Plants are attached by rhizoidal, postrate growths at first, but later becoming free floating. This genus shows a heterotrichous habit and the filament is basically uniseriate, growing from an apical cell. Cell 25 µm in diameter, 17.5 µm long. The cells may have many small, disclike chloroplasts.

Epiphytic on Phragmites australis, Ceratophyllum demersum, & Potamogeton pectinatus.

Division: Chrysophyta

Class: Xanthophyceae:

Order: Heterococcales

Family: Botryochloridaceae

Characiopsis spinifer Printz (pl. 2, Fig. 15) **(New record)**

(Prescott 1982, 359, pl.94, Figs. 3-5).

Cells avoid to elliptic, with an acute tip, practically sessile on abroad attaching disc-chromatophores several disc-shaped bodies; cells 10 µm in diameter, 35 µm long. Epiphytic on *Phragmites australis*.

Division: Cyanophyta

Class: Myxophyceae

Order: Chroococcales

Family: Chroococcaceae

Chroococcus dispersus (Keissl.) Lemmermann (pl. 2, Fig. 16)

(Prescott 1982, 447, pl. 100, Fig. 7).

A free-floating, flattened, ovate or irregularly-shaped colony of 4-16 spherical cells, which are either single or arranged in small clusters, evenly distributed at some distance from one another in the mucilaginous envelope; individual cell sheaths not evident; cells

contents bright blue-green sometimes gray-green or pale blue-green; cells 2.5 µm in diameter.
Epiphytic on all host studied plants.

Chroococcus limneticus Lemmermann (pl. 2, Fig. 17)
(Desikachary 1959, 107, pl. 26, Fig. 2; Prescott 1982, 448, pl.100, Figs. 4-5)

A free-floating, spherical or ovate colony of 4 spherical cells rather closely and evenly arranged, sometimes in groups of 2-4 cells as a result of rapid cell division; individual cell sheath usually indistinct and confluent with the hyaline, mucilaginous colonial granular; cells 10.4 µm in diameter, without sheath, with sheath 15 µm in diameter.
Epiphytic on all host studied plants.

Chroococccus turgidus (Kütz.) Nägali (pl. 2, Fig. 18)
(Desikachary 1959, 101, pl.26, Fig. 6; Nurul-Islam & Nahar 1967, 144, pl. 3, Fig.4; Prescott 1982, 450, pl. 100, Fig. 19).

A free-floating colony of 2-ovoid or hemispherical cells in closed by a very wide usually hyaline and lamellate colonial sheath; cells bright blue-green, contents sometimes coarsely granular, inclosed by individual sheaths, 10-12.5 µm in diameter without sheath 15 -25 µm wide including sheath.
Epiphytic on all host studied plants.

Gomphosphaeria lacustris Chodat (pl. 2, Fig. 19)
(Desikachary 1959, 150, pl.28, Figs.4-6, 12-13; Pankow 1971, 33, Fig.6; Prescott 1982, 473, pl.106, Fig.8)

Cells spherical or sometimes reniform, arranged in clusters of 4-8 individual at the ends of fine gelatinous strand, clutser at same distance from one another incopious gelatinous envelopes; cells 1.25-2.5 µm in diameter 6.2 µm long.
Epiphytic on all host studied plants.

Order: Hormogonales
Sub order: Hormocystineae
Family: Oscillatoriaceae

Lyngbya majuscula Harvey (pl. 2, Fig. 20a,b)
(Desikachary 1959, pl.48, Figs. 7, pl. 49, Fig. 12 and pl. 52, Fig. 10; Pankow 1971, 60, Fig.40).

Thallus expanded, dull blue-green to brown or yellowish brown; filaments very long, curved or seldom only slightly coild; sheath colourless, lamellated up to 11 µm thick, trichome blue-green brownish green not constricted at the cross wall; not attenuated at the ends; 47.5 µm in diameter; cells very short, 1/6-1/5 times as long as broad, 2.5 µm, cross wall not granulated; end cells rotund, calyptra absent.
Epiphytic on all host studied plants.

Division: Cyanophyta
Class: Myxophyceae

Order: Chroococcales

Family: Chroococcaceae

Merismopedia glauca (Ehr.) Nägeli (pl. 2, Fig. 21).

(Desikachary 1959, 155, pl.29; Nurul-Islam &Nahar 1967, 144, pl.3, Fig. 4; Fig. 5; Nurul-Islam & Zaman 1975, 54, pl.8, Fig. 142; Prescott 1982, 459, pl.101, Figs. 2-4).

Colony of 16-64 ovate or hemispherical cells, very regularly arranged to form quadrangular colonies; 3.13-5 µm in diameter; colony 28.6-32 µm in diameter; cell contents bright blue-green, homogeneous.

Epiphytic on all host studied plants.

Merismopedia tenuissima Lemmermann (pl. 2, Fig. 22).

(Desikachary 1959, 154, pl. 29, Fig. 7; pl. 30, Figs. 8, 9; Prescott 1982, 459, pl.102, Fig. 10)

Small rectangular plates of usually 16 minute ovate cells which are closely spaced within a wide gelatinous sheath; cells 2.5 µm in diameter, cell contents pale blue-green or gray-green, homogenous; colony 15.6-17µm in diameter.

Epiphytic on all host studied plants.

Order: Hormogonales

Sub order: Hormocystineae

Family: Oscillatoriaceae

Oscillatoria princeps Voucher (pl. 2, Fig. 23)

(Desikachary 1959, 210, pl.37, Figs.1, 10, 11, 13, 14; Nurul-Islam 1969, 355, pl.3, Fig. 3; Nurul-Islam & Zaman 1975, 55, pl.8, Fig. 129; Nurul-Islam & Uddin 1978, 76, pl.1, Figs. 15, 31-32; Prescott, 1982, 489-490, pl. 110, Fig.1)

Trichomes solitary or loosely entangled to form small floating plant masses, which are black-green in color; trichomes very slightly and tapering at the apex, apical cell usually not capitates, sometimes very slightly so, the outer membrane broadly convex and smooth. Cells 25 µm in diameter, 5 µm long; not constricted at the cross walls, which are not granular;; cell contents densely granular.

Epiphytic on Phragmites australis, Ceratophyllum demersum, & Typha domengensis.

Division: Chrysophyta

Class: Bacillariophyceae

Order I: Pennales

Achnanthes brevipes var. intermedia (Kütz.) Cleve (pl. 3, Fig. 24a. Valve view, 24b. Girdle view)

(Hustedt 1930, 210, Fig. 309; Pankow 1976, pl.13, Fig. 5; Snoeijs 1993, 17, Fig. 2)

L.28.08-37.44 µm; W.9.36-10.4 µm; Striae 9-10 in 10 µm.

Epiphytic on all host studied plants.

Achnanthes hungarica Grunow (pl. 3, Fig. 25a,b)

(Hustedt 1930, 201, Fig. 283; Patrick & Reimer 1966, 269-270, pl.18, Figs.1-10; Pankow 1976, 158, Fig. 324; Lawson & Rushforth 1975, 22, pl.11, Figs.4-7; pl.12, Fig.1-2; Czarnecki &

Blinn, 1978,41, pl.10, Fig.1)
L.9.36-15.6 μm; W. 3.12-5.2 μm; striae unclear.
Epiphytic on all host studied plants.

Achnanthes microcephala (Kütz.) Grunow (pl. 3, Fig. 26)
(Hustedt 1930, 198, Fig. 273; Patrick &Reimer 1966, 250-251, pl.16, Figs. 1-2, Lawson & Rushforth 1975, 23, pl.12, Fig. 6-7; Germain 1981, 109, pl.41, Fig.1-11).
L.14.56-19.7 6μm; W.3.12 μm; striae unclear.
Epiphytic on all host studied plants.

Achnanthes minutissima Kützing (pl. 3, Fig. 27)
(Hustedt 1930, 198, Fig. 274; Patrick & Reimer 1966, 253-254, pl.16, Figs. 9-10; Czarnecki & Blinn 1977, 27, pl.7, Figs.7-8; Czarnecki & Blinn 1978, 43, pl.11, Fig.2; Germain 1981, 109, pl.41, Fig.12-19)
L.19.76 μm; W.3.12 μm; striae unclear.
Epiphytic on all host studied plants.

Amphora coffeaeformis Agardh (pl. 3, Fig. 28. Girdle view)
(Hustedt 1930, 345, Fig. 634; Patrick & Reimer 1975, 78-79, pl.14, Figs.11-12 ; Czarnecki & Blinn 1977, 37, pl.9, Fig.1; Czarnecki & Blinn 1978, 55, pl.14, Fig.1)
L.23-31.2 μm ;W.10.2 μm; striae 18-20 in 10 μm.
Epiphytic on all host studied plants.

Amphora commutata Grunow (pl. 3, Fig. 29)
(Hustedt 1930, 345, Fig. 632; Pankow 1976, 281, pl.18, Fig. 5; Snoeijs &Vibaste 1994, 19, Fig. 107).
L: 41.04 μm; W. 22.5 μm; striae 9 in 10 μm.
Epiphytic on all host studied plants.

Amphora mexicana var. *major* Cleve (pl. 3, Fig. 30) **(New record)**
(Pankow 1976, 278, pl.19 Fig.7)
L.101.92 μm; W.67.6 μm ; striae 8 in 10 μm.
Epiphytic on all host studied plants.

Anomoeoneis exilis (Kütz.) Cleve (pl. 3, Fig. 31)
(Hustedt 1930, 264, Fig. 429; Al-Zubaidi 1985, 110, pl.3, Fig.60)
L. 21.84 μm ; W. 5.2 μm; striae 15-16 in 10μm.
Epiphytic on all host studied plants.

Cocconeis pediculus Ehrenberg (pl. 3, Fig. 32)
(Hustedt 1930, 188, Fig.259; Patrick &Reimer 1966, 240, pl.15, Figs. 3-4; Lawson &Rushforth 1975, 20, pl.10, Fig. 1, 4; Czarnecki & Blinn 1977, 71, pl.18, Fig.7; Czarnecki & Blinn 1978, 45, pl.11, Fig.6; Germain 1981, pl.104, Figs. 7-9 ; Hadi *et al*. 1984, 526, pl.9, Figs. 161-162; Snoeijs 1993, 37, Fig. 23).
L. 21.84 μm; W. 16.64 μm; striae 19 and 18-19 punctae in 10μm.
Epiphytic on all host studied plants.

Cocconeis placentula Ehrenberg (pl. 3, Fig. 33)
(Hustedt 1930, 189, Fig. 260; Patrick & Reimer

1966, 240-241, pl.15, Figs. 7; Czarnecki & Blinn 1977, 42, pl.6, Fig.1; Czarnecki & Blinn 1978, 45, pl.11, Fig.7; Germain 1981, 102, pl.38, Figs. 38-39 ; Snoeijs 1993, 38, Fig. 24).

L. 31.2 µm ; W. 11.44 µm; striae 20 in 10µm.

Epiphytic on all host studied plants.

Cocconeis placentula var. *euglypta* (Ehr.) Cleve (pl. 3, Fig. 34)

(Hustedt 1930, 190, Fig.261; Patrick &Reimer 1966, 241, pl.15, Figs. 8; pl.9, Fig. 158; Lawson & Rushforth 1975, 21, pl.11, Fig. 1; Foged 1977, 35, pl.15, Figs. 3a, 3b; Czarnecki & Blinn 1977, 24, pl.6, Fig.2; Hadi *et al*. 1984, 526, pl.3, Fig. 45; Al-Zubaidi 1985, 105, pl.2, Fig. 32; Snoeijs & Balashova 1998, 38, Fig. 26).

L. 17.68 µm; W. 9.36 µm; striae 19-20 in 10 µm (Pseudoraphe valve).

Epiphytic on all host studied plants.

Cocconeis placentula var. *lineata* (Ehr.) Cleve (pl. 3, Fig. 35)

(Hustedt 1930, 190, Fig. 262; Patrick & Reimer 1966, 242, pl.15, Figs. 5-6; Lawson & Rushforth 1975, 21, pl.10, Fig. 2-3; Foged 1976, 15, pl.5, Fig. 1; pl.9, Fig. 157; Czarnecki &Blinn 1977, 72, pl.6, Figs. 3-4; Czarnecki & Blinn 1978, 46, pl.11, Fig. 9; Hadi *et al*. 1984, 528, pl.3, Fig. 46; Al-Zubaidi 1985, 106, pl.2, Fig. 33).

L. 34.32 µm ; W.17.68 µm; striae 20 in 10µm.

Epiphytic on all host studied plants.

Gomphonema lanceolatum Ehrenberg (pl. 3, Fig. 36)

(Hustedt 1930, 376, Fig.700; Foged 1971, 290, pl.17, Fig. 14; Hirano 1973, 117, pl.3, Fig.7).

L. 30.16-46.8 µm; W. 5.2-7.28 µm; striae 12 in 10µm.

Epiphytic on all host studied plants

Gomphonema olivaceum (Lyng.) Kützing (pl. 3, Fig. 37)

(Hustedt 1930, 378, Fig. 719; Lawson & Rushforth 1975, 49, pl.35, Figs.3; Patrick & Reimer 1975, 139-140, pl.18, Fig.13-14; Foged 1977,69, pl.12, Fig. 12;pl.12,Fig.20; Czarnecki &Blinn 1978, pl.13,Fig.7;Snoeijs 1993, 63, Fig. 49).

L. 18.72-22.88 µm; W. 6.24-7.28 µm; striae 12-14 in 10µm.

Epiphytic on all host studied plants.

Gomphonema parvulum (Kütz) Grunow (pl. 3, Fig. 38)

(Hustedt 1930, 372, Fig. 713c; Lawson & Rushforth 1975, 50, pl.35, Figs. 5; Patrick & Reimer 1975, 122-123, pl.17, Figs.7-12; Czarnecki & Blinn 1977, 31, pl.8, Fig.1; Czarnecki & Blinn 1978, 53, pl.13, Fig.8; Germain 1981, 308, pl.114, Figs. 23-27 ; Hadi *et al*. 1984, 536, pl.5, Fig.82; pl.12, Fig. 208; Al-Zubaidi 1985 , 119, pl.6, Fig.104).

L. 12.4-26 µm; W. 4.1-5.2 µm; striae 14-17 in 10µm

Epiphytic on all host studied plants.

Gomphonema sphaerophorum Ehrenberg (pl. 3, Fig. 39) **(New record)**
(Hustedt 1930, 372, Fig.695; Foged 1971, 291, pl.16, Fig. 18).
L. 21.84-30.4 μm; W. 7.28 μm; striae 12-14 in 10μm.
Epiphytic on all host studied plants.

Navicula cincta (Ehr.) Kützing (pl. 3, Fig. 40)
(Hustedt 1930, 298, Fig.510; Patrick & Reimer 1966, 516, pl.49, Fig.8; Pankow 1976, 236, Fig.491; Czarnecki & Blinn 1977, 47, pl.11, Fig.8; Czarnecki & Blinn 1978, 79, pl.18, Fig.6;Germain, 1981, 186, pl.71, Fig. 8-13; Al-Zubaidi 1985, 110, pl.4, Fig.61).
L. 23.92-31.2 μm; W. 6.24-7.28 μm; striae 17 in 10μm
Epiphytic on all host studied plants.

Navicula cryptocephala Kützing (pl. 3, Fig. 41)
(Hustedt 1930, 295, Fig.496; Patrick &Reimer 1966, 503-504, pl.48, Fig.3; Lawson & Rushforth 1975, 32, pl.20, Fig. 3; Czarnecki &Blinn 1977, 47, pl.11, Fig.9; Czarnecki & Blinn 1978, 80, pl.18, Fig.9; Germain, 1981, 188, pl.72, Fig. 1-5; 1984; Snoeijs & Vilbaste 1994, 69, Fig. 157).
L. 20.8-31.2 μm; W. 6.24-7.28 μm; striae 16-18 in 10μm.
Epiphytic on all host studied plants.

Navicula cuspidata Kützing (pl. 3, Fig. 42)
(Hustedt 1930, 268, Fig.433; Patrick & Reimer 1966, 464, pl.43, Fig.9-10; Foged 1971, 300, pl.11, Fig. 2-4; Lawson & Rushforth 1975, 32, pl.21, Figs. 3, 6; Czarnecki & Blinn 1977, 48, pl.20, Fig.3; Czarnecki &Blinn 1978, 81, pl.18, Fig.12; Germain, 1981, 167, pl.63, Fig. 1-4; Hadi *et al*. 1984, 532, pl.11, Figs.191-192).
L. 73.92 μm; W. 14.56 μm; striae 24 (tranverse) in 10μm.
Epiphytic on Phragmites australis, Ceratophyllum demersum, & Typha domengensis.

Navicula inflata Donkin (pl. 3, Fig. 43)
(Hustedt 1930, 283, Fig.470; Cleve-Euler 1953, 175, Fig. 867; Hinton & Maulood 1980, 483, Fig. 27; Al-Zubaidi 1985, 112, pl.4, Fig.65).
L. 27-39.52 μm; W. 6.2-8.32 μm; striae more than 21 in 10μm
Epiphytic on all host studied plants.

Navicula radiosa Kützing (pl. 3, Fig. 44)
(Hustedt 1930, 299, Fig.513; Patrick &Reimer 1966, 509, pl.48, Fig.15; Lawson & Rushforth 1975, 35, pl.23, Fig. 8; Czarnecki &Blinn 1978, 88, pl.20, Fig.10; Germain 1981, 182, pl.70, Fig. 1-5; Hadi *et al*. 1984, 533, pl.4, Fig.60; Al-Zubaidi 1985, 113, pl.4, Fig.72; Snoeijs &Kasperoviciene 1994, 78, Fig. 366).
L. 74.8-79.4 μm ; W. 10.4-11.4 μm; striae 10-12 in 10μm.
Epiphytic on all host studied plants.

Navicula radiosa var. *tenella* (Bréb.) Grunow (pl. 3, Fig. 45)
(Hustedt 1930, 299, Fig.513; Patrick & Reimer 1966, 510, pl.48, Fig.17 ; Lawson & Rushforth 1975, 35, pl.23, Fig. 7; Czarnecki &Blinn 1978, 88, pl.20, Fig.11; Al-Zubaidi 1985, 113, pl.4, Fig.73).
L. 28.2-45.7µm; W. 5.2-7.28 µm; striae 14-17 in 10µm.
Epiphytic on all host studied plants.

Nitzschia amphibia Grunow (pl. 3, Fig. 46a,b)
(Hustedt 1930, 414, Fig. 793; Lawson & Rushforth 1975, 53, pl.38, Figs.3, 8-9; Czarnecki & Blinn 1977, 64, pl.16, Fig.4; Czarnecki &Blinn 1978, 108, pl.23, Fig.9; Foged 1978, 103, pl.46, Fig. 11-13; Germain 1981, 358, pl.135, Figs. 32-37; Al-Zubaidi 1985 , 121, pl.6, Fig.115).
L. 17.6-27.04 µm; W. 4.06-5.1 µm; striae 16-19 in 10µm. Keel punctae, 8-9 in 10µm.
Epiphytic on all host studied plants.

Nitzschia frustulum Kützing (pl. 3, Fig. 47a,b)
(Hustedt 1930, 414, Fig. 795; Czarnecki & Blinn 1977, 66, pl.17, Fig.1; Czarnecki &Blinn 1978, 111, pl.24, Fig.7; Snoeijs 1993, 90, Fig. 76).
L. 22.2-46.3 µm; W. 5.2 µm; striae 20 in 10µm; Keel punctae 9-10 in 10µm.
Epiphytic on all host studied plants.

Nitzschia palea (Kütz.) W. Smith (pl. 3, Fig. 48)
(Hustedt 1930, 416, Fig. 801; Cleve-Euler 1952, 91, Figs. 1505a-c; Hirano 1973, 119, pl.7, Fig.6; Lawson &Rushforth 1975, 54, pl.39, Figs. 1-2; Foged 1976, 42, pl.20, Fig. 11; Czarnecki & Blinn 1977, 68, pl.17, Fig.8; Clarck & Rushforth 1977, 103, pl.8, Fig.9; Czarnecki & Blinn 1978, 114, pl.25, Fig.4; Foged 1978, 108, pl.46, Fig. 22; Hadi *et al*. 1984, 539, pl.6, Fig.104; pl.13, Figs. 230-231;).
L. 20.8-33.28 µm; W. 2.6-4.16 µm; Keel punctae 14-15 in 10µm; striae very fine
Epiphytic on all host studied plants.

Rhoicosphenia curvata (Kütz.) Grunow (pl.4, Fig.49a.Girdle view, 49b.Valve view)
(Hustedt 1930, 211, Fig. 311; Patrick &Reimer 1966, 282, pl.20, Figs.1-5; Lawson & Rushforth 1975,24, pl.13, Figs.,6-7; Czarnecki &Blinn 1977,72, pl.18,Fig.8; Foged 1977, 106, pl.15, Figs. 13a, 13b,14; Germain 1981,118, pl.44, Fig.21, pl.168, Fig.13; Hadi *et al*., 1984, 528, pl.3, Fig.53; pl.9, Fig.159; Al-Zubaidi 1985 ,106, pl.2, Fig. 36; Snoeijs 1993, 95, Fig.81;).
L. 31.24-42.64 µm; W. 6.24-8.32 µm; striae 14 in 10µm.
Epiphytic on all host studied plants.

Rhopalodia gibba (Ehr.) Müller (pl. 4, Fig. 50a. Valve view, 50b. Girdle view)
(Hustedt 1930, 390, Fig. 740; Patrick &Reimer 1975, 189, pl.28, Fig.1; Lawson & Rushforth 1975, 52, pl.37, Fig. 3; Czarnecki & Blinn 1977, 29, pl.19, Fig.4; Czarnecki & Blinn 1978, 101, pl.22, Fig.14; Hadi *et al* 1984, pl.12, Fig.218-

219).

L. 76.96-80 µm; W. 18.72 µm; striae 16-19 in 10µm.

Epiphytic on all host studied plants.

Synedra affinis Kützing (pl. 4, Fig. 51a,b)

(Hustedt 1930, 159, Fig. 184; Germain 1981, 78, pl.26, Figs. 5-10).

L: 124.8-132.08 µm; W. 4.16-5.2 µm; striae 11-14 in 10 µm.

Epiphytic on all host studied plants.

Synedra fasciculata (Kütz.) Grunow (pl. 4, Fig. 52)

(Patrick & Reimer 1966, 141, pl. 5, Figs. 17-18; Hadi *et al*. 1984, 522, pl. 2, Figs. 28; pl. 9; Fig. 152; Al-Zubaidi 1985, 104, pl. 1; Figs. 20-21).

L: 153-184.08 µm; W. 4.16-5.2 µm; striae 12-14 in 10 µm.

Epiphytic on all host studied plants.

Synedra ulna (Nitz.) Ehrenberg (pl. 4, Fig. 53)

(Hustedt 1930, 154, Fig. 166; Patrick 7&Reimer 1966, 148, pl. 7, Figs. 1-2; Germain 1981, 76, pl.24, Figs. 1-6; pl. 168, Fig.8, Hadi *et al*. 1984, 324, pl. 1, Figs. 1-6; pl. 8)

L: 145-230 µm; W. 4.65-7.2 µm; 9-10 striae in 10µm.

Epiphytic on all host studied plants.

Synedra ulna var. *biceps* (pl. 4, Fig. 54)

(Hustedt 1930, 154, Fig. 166; Patrick &Reimer 1966, 151, pl. 8, Figs. 2a-b; Hadi *et al*. 1984, 524, pl. 1, Figs. 11-12; pl. 8; Figs. 150-151).

L: 208-322 µm; W. 5.2-7.2 µm; striae 8-9 in 10 µm.

Epiphytic on all host studied plants.

Oredr II: Centrales

Cyclotella meneghiniana Kützing (pl. 4, Fig. 55a,b)

(Hustedt 1930, 100, Fig. 65; Lawson & Rushforth 1975, 9, pl.2, Fig.1; Czarnecki & Blinn 1977, 18, pl. 18, Fig.2, Czarnecki & Blinn 1978; pl.4, Fig.4; Hadi *et al*. 1984, 518, pl.1, Fig. 23; pl.8, Fig. 136; Al-Zubaidi 1985 ،102, pl.1, Fig.6; Snoeijs 1993, 46, Fig.32)

Dia. 14.56-28.08 µm; Costae 8-9 in 10µm.

Epiphytic on all host studied plants.

Several limnological investigations were focused on list of identified algae (Hadi & Al-Zubaidi 2001 and Hassan *et al*. 2010) while a few studies dealt on the morphology and taxonomy of algae in Iraq (Hadi *et al*. 1984; Al-Handal 1995). The current research contributes to the future plan to getting an illustration of all the Iraqi fresh water algae.

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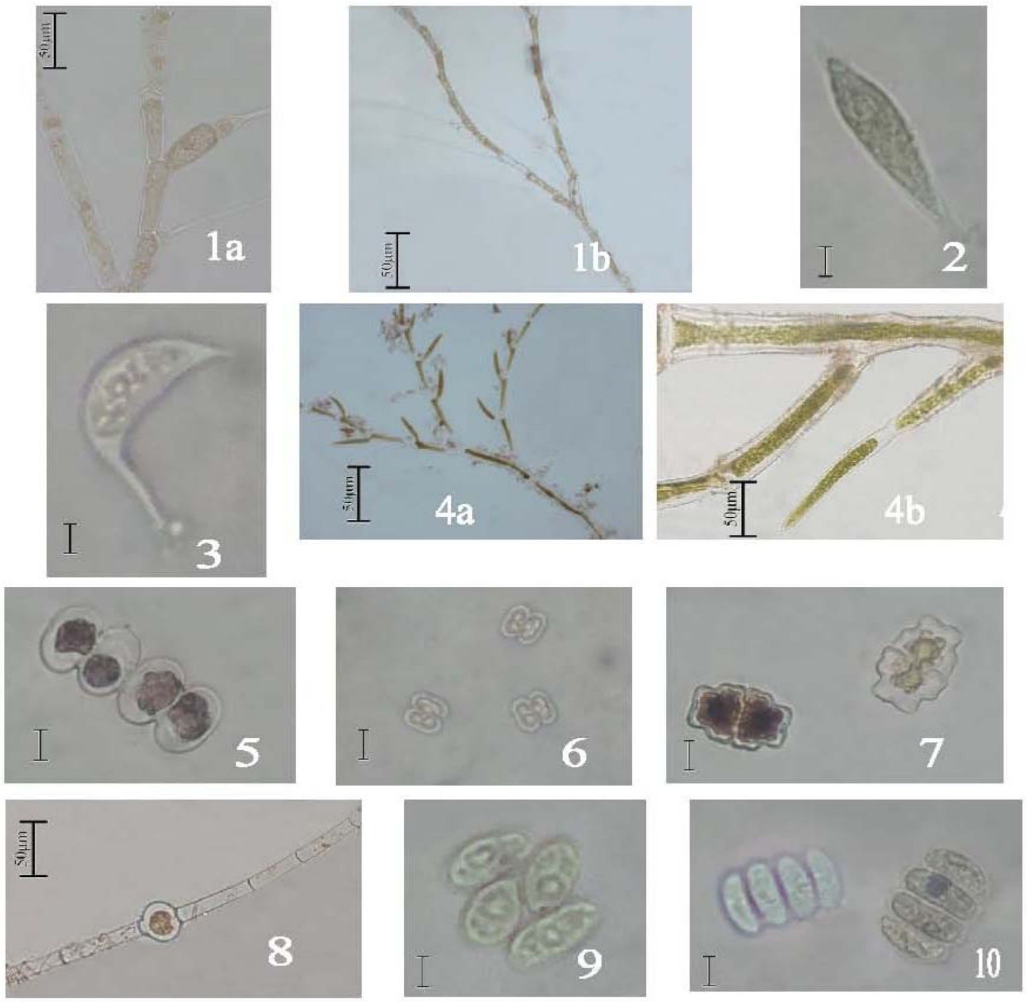

Plate (1): Class I: Chlorophyceae: figs. 1a, 1b. *Bulbochaete* sp., 2. *Characium ambiguum*, 3. *Characium ornithocephalum*, 4a, 4b. *Cladophora glomerata*, 5. *Cosmarium subtumidium*, 6. *Cosmocladium* sp., 7. *Euastrum dubium*, 8. *Oedogonium sociale*, 9. *Scenedesmus arcuatus*, 10. *Scenedesmus bijuga* (each scale represents 10 µm unless otherwise mentioned).

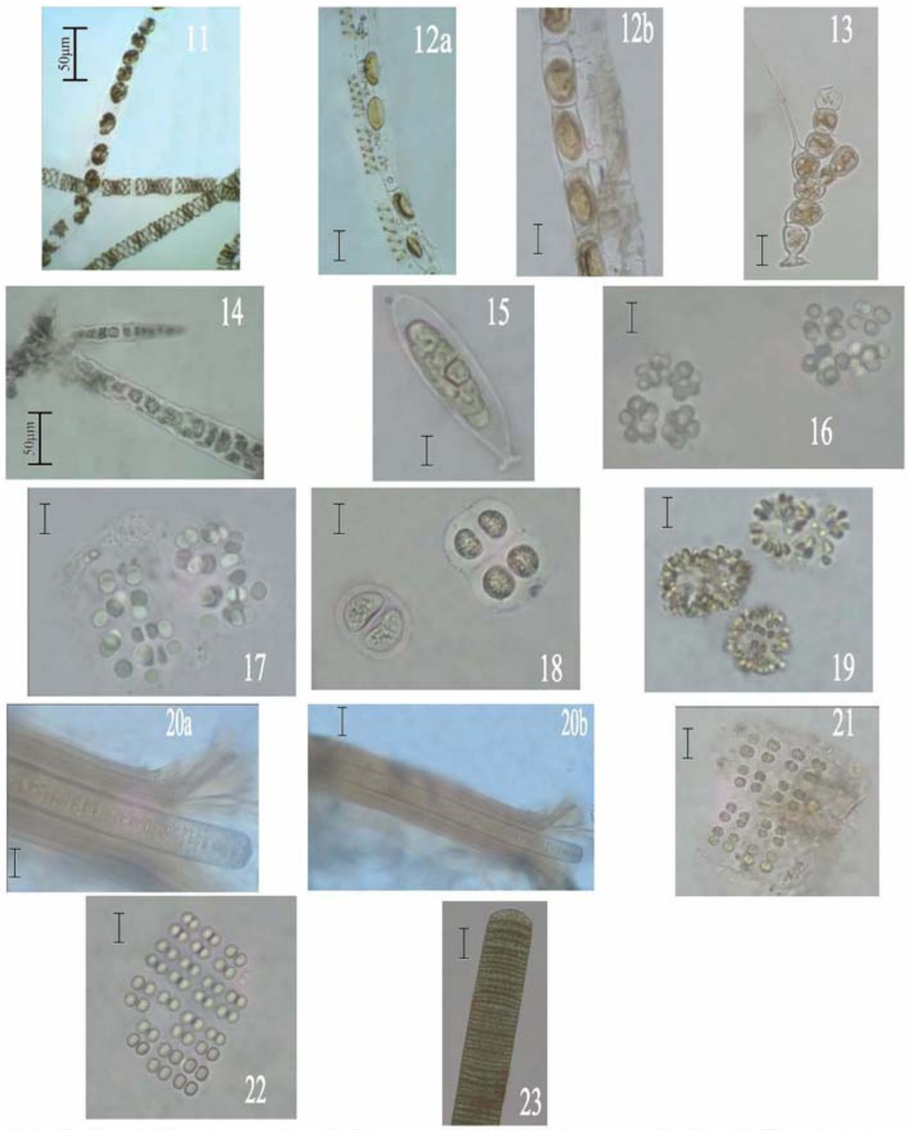

Plate (2): Class I: Chlorophyceae: figs. 11. *Spirogyra nitida*, 12a,b. *Spirogyra scrobiculata*, 13. *Thamniochaete* sp. Class II: Rhodophyceae: 14. *Compsopogon* sp.; Class III: Xanthophyceae: 15. *Characiopsis spinifer*; Class IV: Myxophyceae: figs. 16. *Chroococcus dispersus*, 17. *Chroococcus limneticus*, 18. *Chroococcus turgidus*, 19. *Gomphosphaeria lacustris*, 20a,b. *Lyngbya majuscula* , 21. *Merismopedia glauca*, 22. *Merismopedia tenuissima*, 23. *Oscillatoria princeps* (each scale represents 10 µm unless otherwise mentioned).

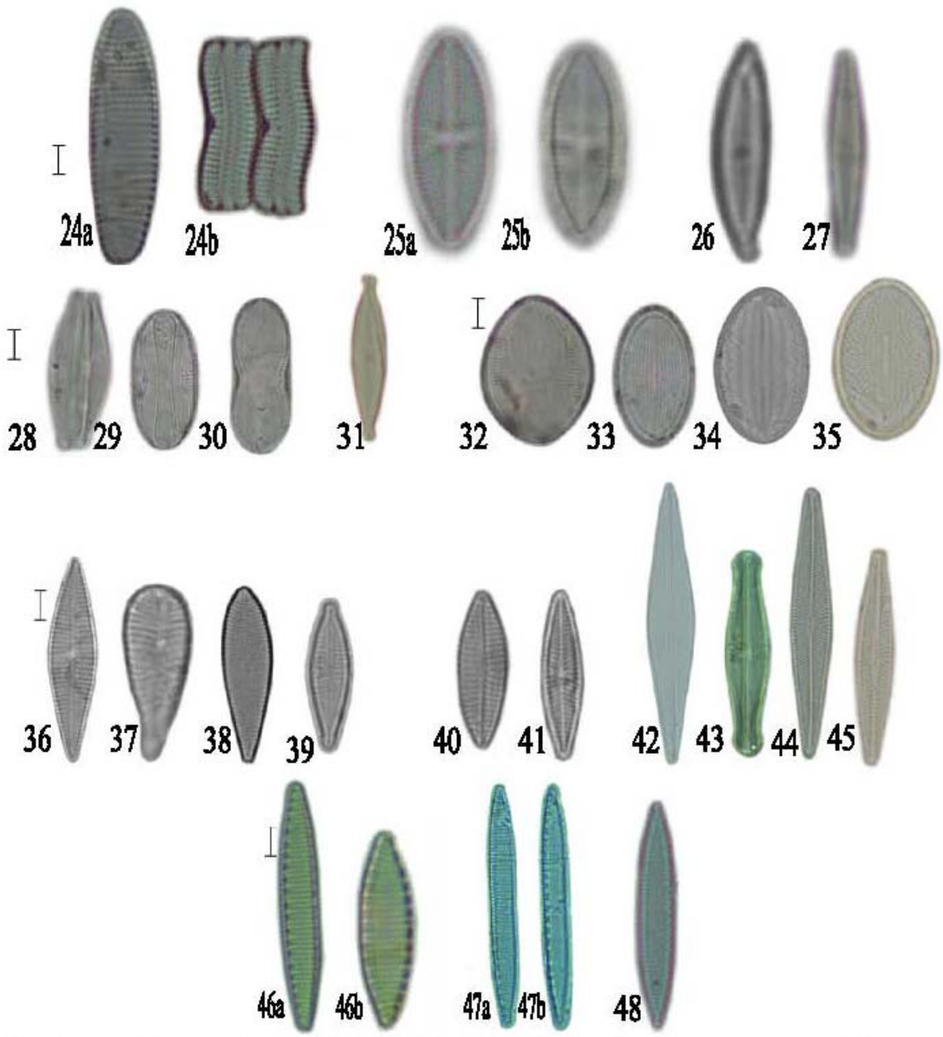

Plate (3): Class V: Bacillariophyceae (order Pennales): 24a,b. *Achnanthes brevipes* var. *intermedia*, 25a, b. *Achnanthes hungarica*, 26. *Achnanthes microcephala*, 27. *Achnanthes minutissima*, 28. *Amphora coffeaeformis*, 29. *Amphora commutata*, 30. *Amphora maxicana* var. *major*, 31. *Anomoeoneis exilis*, 32. *Cocconeis pediculus*, 33. *Cocconeis placentula*, 34. *Cocconeis placentula* var. *euglypta*, 35. *Cocconeis placentula* var. *lineata.*, 36. *Gomphonema lanceolatum*, 37. *Gomphonema olivaceum*, 38. *Gomphonema parvulum*, 39. *Gomphonema sphaerophorum*, 40. *Navicula cincta*, 41. *Navicula cryptocephala*, 42. *Navicula cuspidata*, 43. *Navicula inflata*, 44. *Navicula radiosa*, 45. *Navicula radiosa* var. *tenella*, 46a, b. *Nitzschia amphibia*, 47a, b. *Nitzschia frustulum*, 48. *Nitzschia palea*, (each scale represents 10 µm unless otherwise mentioned).

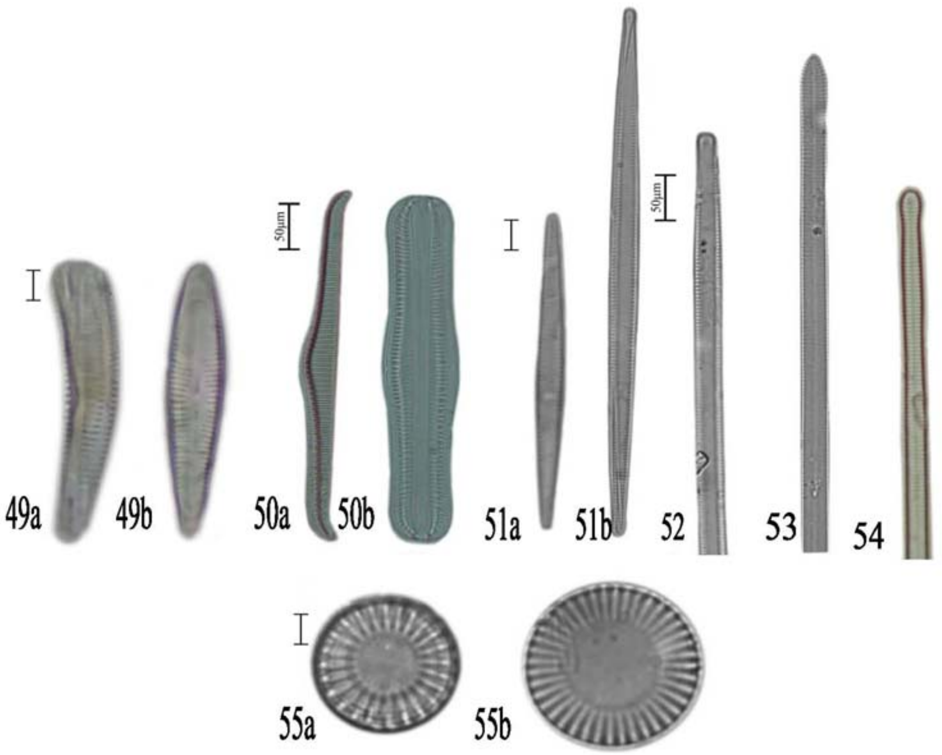

Plate (4): Class V: Bacillariophyceae (order Pennales) : 49 a, b. *Rhoicosphenia curvata* ,
50 a,b. *Rhopalodia gibba* , 51a, b. *Synedra affinis,* 52. *Synedra fascicu lata*, 53. *Synedra ulna,* 54. *Synedra ulna* var. *biceps* ;
(order Centrales) : 55*a*, b. *Cyclotella meneghiniana* (each scale represents 10 µm unless otherwise mentioned).