



Description of some phytoplankton algae (Non- diatoms algae) in Al-Salhia River (small shatt Al-Arab) and recorded new species in Iraq

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Abstract

The present study was carried out to contribute to the knowledge of freshwater algae in Iraq .This study carried out on Phytoplankton community in Al-Salhia river (small shatt Al-Arab), and contains the description of many algal species that were identified in the Al-Salhia river and nine new records will be added to the Algal Flora list of Iraq, A total of 66 taxa of phytoplankton identified during this study belonged to four division of algae dominated by chlorophyta which constitute 56.06 % of the total number of the species followed by cyanophyta by 31.81 % and euglenophyta by 7.57 % respectively , pyrrophyta constitute the 4.54 % . Samples were collected at (5) stations, from March 2014 to February 2015.

Keywords; Al-Salhia River , phytoplankton , small shatt Al-Arab , Non diatoms algae,new recorded

Introduction

In algae nutrition are self and work photosynthetic,most of algae possess the two phytoplanktonic and benthic phase livetime [1]. Phytoplankton, regarded as the basic component of an aquatic food chain, is the resource of oxygen and the main autochthonous primary producers [2] , the benthic algae have essential roles in preliminary production, stabilizing sediment, nutrient cycles, and transport of energy between sediment and water column [3].Hydrological element are mainly vital for formative the increase of phytoplankton in rivers than in lakes, live mass of phytoplankton in lakes associated the great quantity of nutrients where as in the rivers they are linked elements hydrological [4].In Iraq there are many research that study specific structure and abundance in various

aqueous system [5;6;7;8;9;10;11]. Algal species composition was basic characteristic for many researchs in Iraq [12 ;13 ;14;15;16 ;17] . Work some researchers to collect diferent dispersed pamphlet of algae in iraq in checklist such as [18] that 1296 taxa were integrated , whereas [19] 1900 species were scheduled , [20] that 2312 taxa were incorporated in adding to that a checklist was available by [21]) included 722 algal kind only in Diyala River . Recently about 2647 algal taxa which reported by[22].A study of [23] which describe afew(non diatom) epiphytic algae in Al-hawizah marsh south of Iraq , [24] studied distribution algae in Baghdad after collect sample from various area. Fifteen new species register by[25] at upon section of Euphrates river and add [26] thirty-eight new records for algal species of Iraq's marshes . Many researchers have carried out researchs on aquatic ecology and environment phytoplankton such as[27;28;29].

Materials and Methods

Al-salhia river also call (small shatt Al-Arab) is branched from shatt Al-Arab which located to the south of it, at the opposite side of the khurh river and span southwardly to meet with shatt Al-Arab again near abu Al-khaseb and surrounds the Al-Salhia island, which lies south east of the basrah city.The,length Al-Salhia river about 12 Km , width 40 m ,depth 3-5 m (Figure 1).

The recent study was implemented from March 2014 to February 2015. Phytoplankton was collect from the different sites with Phytoplankton net and reserve by us Formalin solution(4%) , and lougle's solution ,classification of the Phytoplankton pinpointed (non diatom group algae) by dependence on (30-47).Identifications of algae were prepared in an Olympus microscope with connection Camera and microns (μm) used to describe the diameter, long and width of vary examined taxon. All the identified algae were arranged scientifically following Prescott [30]. The classification references were listed next to each taxon.



Figure 1: google earth showing the sampling station in Al-Salhia river (small shatt Al-Arab) south east of the Basrah city.

Results and discussions

In this study sixty six species of phytoplankton were identified and nine of it first once recorded in Iraq. These

species belonged to thirty six genera, five classes and four divisions. All these species is non diatomic phytoplankton. The diatomic species will describe in future. Structural terms are illustrated in the next listed [30] followed with identified taxon in addition of their photography.

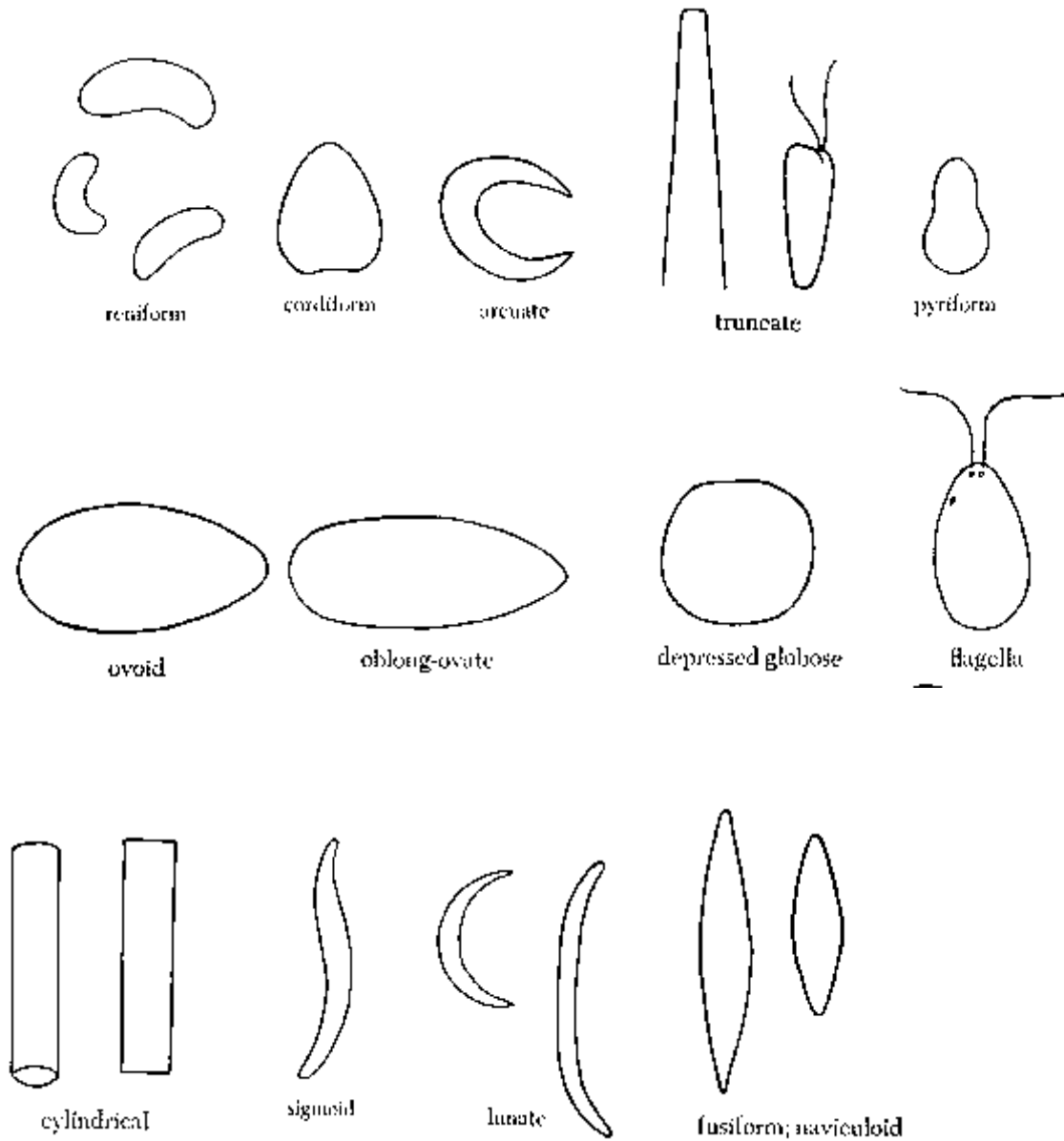


Fig.2:listed forms illustrated Structural terms for identified taxon

Division (1): Chlorophyta

Class: Chlorophyceae

Order: volvocales

Family (1): Chlamydomonadacea

Genus: *Carteria*

Species: *Carteria cordiformis* (Carter) Diesing (pl.1, fig.1)

[30] 73 , pl.1, figs.20).

Cells cordiform , vaster in the front terminus contain 4 flagella chloroplast a sublime parietal cup. cells 13 μm in diameter, 14.4 μm long .

Genus: *Chlamydomonas*

Species: *Chlamydomonas angulosa* Dill (pl.1, fig.2)

[30] 70, pl.1, figs.3).

Cells broadly cylindric to ovoid ,often truncated anteriorly and with a prominent papilla. The flagella as long as or slightly longer than the cell body .Chloroplast ,parietal cup with a large angular pyrenoid in the base, pigment spot anterior and lateral . cells 12 -14 μm in diameter ,16-18 μm long.

Species: *Chlamydomonas globosa* Snow (pl.1, fig. 3)

[30] 71, pl. 1, figs. 8, 9).

Cells broadly ovoid to globose, inclosed in a hyaline , anterior papilla absent; gelatinous sheath, 1 contractile vacuole in the anterior end of cell . Chloroplast a dense ,parietal cup with a basal pyrenoid ; pigment-spot lens-shaped . cells 4-8 μm in diameter, 10-17 μm long.

Family(2):volvocaceae

Genus: *pandorina*

Species: *pandorina morum* (Muell.)Bory (pl.1, fig. 4)

[30]75, pl.1, figs.23).

Colony usually distinctly ovate as much as 220 μm in diameter, cells pyriform ,crowded, usually 16 in number, 10-15 μm in diameter ,12-17 μm long .

Genus: *Volvox*

Species: *Volvox aureus* Ehr. (pl.1, fig. 5)

[30]78, pl.2, figs.4).

Spherical colonies of 500-3200 ellipsoidal cells, 4.5-6.2 μm in diameter, dioecious, in mature coenobia, 2 or more daughter colonies are present .as many as 21 eggs are formed in female colonies; half of the cells in male coenobia develop antherozoid bundles, zygote 38-62 μm in diameter, with a smooth wall .

Species: *Volvox globator* Linn. (pl.1, fig. 6)

[30]78, pl.2, figs.5).

Ovate or spherical , gelatinous colonies containing as many as 17,000 pyriform or ovoid cells 2 -3.8 μm in diameter, coenobium commonly containing 4 – 7 daughter colonies ; sexual colony with 11 – 17 or up to 40, eggs , each inclosed by a wide gelatinous sheath . zygote 45 -54 μm in diameter, with thick walls exteriorly decorated with wart like , blunt spines and verrucae .

Order(2): chlorococcales

Family(1):chlorococcaceae

Genus: Chlorococcum

Species: *Chlorococcum humicolo (Näegeli) Rabenhorst* (pl.1, fig. 7)

[31]59, pl.1, figs.2).

Cells solitary or number of cells crowded together to form a stratum , spherical . Chloroplast a hallow sphere with a single pyrenoid. Cells 30 μm . in diameter.

Genus: Golenkinia

Species: *Golenkinia paucispina* West & West (pl.1, fig.8)

[30]213,pl.45,fig. 2,[32] 287, pl.2, figs.38).

Cells solitary spherical cells, with afew short setae arising from all sides of the cell wall, Chloroplast cup shaped with 1 pyrenoid. Cells 16-17.5 μm . in diameter; setae about 15 μm long.

Species: *Golenkinia radiata* Chodat, J. (pl.1, fig. 9)

[31]60, pl.1, figs. 5).; [33]220, pl. 3,figs. 36).

Cells solitary, spherical 5.4-9 μm diam.; chloroplast cup shaped, with one pyrenoid cell wall with numerous straight spines arranged irregularly,7.1-11 μm long.

Family(2) : Hydrodictyaceae

Genus: Pediastrum

Species: *Pediastrum boryanum (Turp.) Meneghinii* (pl.1, fig. 10)

[30] 222, pl. 47, fig.9 , pl. 48, figs 1, 3) .

Colony entire; cells 6-sided with granular or smooth walls, peripheral cells with outer margins extended into 2 blunt- tipped processes; cells 10 μm in diameter, 12-16 μm long; 16-celled colony, 49 μm wide, 54.6 μm long.

Family(3) : Coelastraceae

Genus: Coelastrum

Species: *Coelastrum asteroieds* De Notaris (pl.1, fig. 11)

[34]409 , fig.2, c ; [36]84,pl.2 ,fig.28).

Spherical cenobios of 8-16 ovate cells,slightly wedge-shaped and joined together directly by its walls.
Parietal chloroplast with a pyrenoid, cell diameter: 8.3-10 µm.

Species: *Coelastrum microporum* Nügel (pl.1, fig. 12)

[30] 230 , pl. 53. fig. 3;[31]61, Pl. 1, Fig. 220;[35]343, Pl.2, Fig. 44)

Coenobium spherical ,consisted of 10- sheathed ovoid cells , with the narrow end out wardly direction ;cells inter linked by very short ,scarcely discernible gelatinous processes , leaving small intercellular space ; cells 11 µm in diameter including the sheath ; colony 15.2 µm in diameter.

Family(4):oocystiaceae

GENUS:*Ankidesmus*

Species:*Ankistrodesmus bibraianus* (Reinsch) Korshikov, (pl.1, fig. 13) (new recorded)

[33]218, pl. 3 ,figs. 25).

Colonies of 4-16 cells, cells lunated or semicircular, convex side oriented to the center of colony; gradually narrowing to the apex,3.8 -5.2 µm diam., 8-11 µm distance between apices; parietal chloroplast, without pyrenoid.

Genus: *Chlorella*

Species:*Chlorella vulgaris* Beijerinck, Bot. Ztg. (pl.1, fig.14)

[36]82, pl. 1 ,figs.15;[33]218 ,pl.3 ,fig. 23)

Cells spherical, solitary or possibly forming cells small aggregates, spherical; smooth cell wall, 4-7.2 µm diam.; chloroplast cup shaped, with one pyrenoid

Genus: *Dictyosphaerium*

Species:*Dictyosphaerium tetrachotomum* Printz (pl.1, fig. 15) (new recorded)

[34]415 ,figs.4,H ;[35]343 ,pl.2 ,fig. 39)

Synonym: *Dictyosphaerium pulchellum* var *ovatum*

spherical colonies to Irregular, and even ellipticals. Elliptical to oval cells located at from the longitudinal axis of each cell, in the end of fine hyaline pedicels. Chloroplast Parietal coupled with a pyrenoid. Cells 18 µm long,8 µm broad.

Genus: *Kirchneriella*

Species:*Kirchneriella elongate* G.M. Smith (pl.1, fig. 16)

[30]258, pl. 58 ,figs.1;[35]346 ,pl.2 ,fig. 62)

Colony composed of 16 elongate cylindrical , spirally twisted cells , having rounded apices ,one parietal chloroplast , without pyrenoid. cells 3 µm in diameter, 16-25 µm long .

Species:*Kirchneriella microscopica* Nyg. (pl.1, fig. 17)

[32]287 ,pl.3 ,fig. 41)

Colony with 4-8 lunar cells, apices rounded; Chloroplast parietal, without pyrenoid. Distance between the apices of the apices of cells 1-1.5 μm , long 2.8 μm , diameter 0.5-1 μm .

Species: *Kirchneriella obesa* (W. West) Schmidle (pl.1, fig. 18)

[36]82, pl. 2 ,figs.19;[35]346 ,pl.2 ,fig. 63)

Colonies with 8-64 cells, lunated, flattened, with the outer side markedly convex and the inner concave side, poles rounded or slightly attenuated; arranged Irregularly, mucilage not very evident. Chloroplast with 1 pyrenoid, cells 5.8-14 μm long; 5.8-6 μm in diameter.

Genus: *Monoraphidium* (pl.1, fig. 19) (new recorded)

Species: *Monoraphidium arcuatum* (Korshikov) Hindák

[33]219, pl. 3 ,figs. 29;[47]88 ,pl.1 ,fig. 13a,b)

Synonym: *Ankistrodesmus arcuatus*

Cells solitary, arcuated, apices acuminate, 2-3 μm in diameter, as much as 130 μm long; parietal chloroplast, without pyrenoid .

Species: *Monoraphidium contortum* (Thur.) Komárk.-Legn. , (pl.1, fig. 20) (new recorded)

[33]219, pl. 3 ,figs. 30;[32]287 ,pl.3 ,fig. 45)

Synonym: *Ankistrodesmus contortus*

Cells solitary , helicoidal, fusiform-elongated, 1 -2 μm in diameter , 13.5 -33 μm distance between apices ; parietal chloroplast, without pyrenoid.

Species: *Monoraphidium griffithii* (Berk.) Komárk.-Legn., (pl.2, fig.21) (new recorded)

[33]219, pl. 3 ,figs. 31;[35]346 ,pl.2 ,fig. 60)

Synonym: *Closterium griffithii*

Cells solitary, straight , fusiform-elongated, 60.5-67 μm long, 1.5 -2.2 μm diam.; parietal chloroplast, without pyrenoid.

Genus: *Oocystis*

Species: *Oocystis borgei* snow (pl.2, fig.22)

[37]609, pl. 1 ,figs.10)

One cell or groups of 2-8 cells , oviform or elliptic cell, cinctured by the old wall of mother cell, chloroplast either 1 or 4 parietal plaques . cells 10.2 μm in diameter, 12.8 μm long .

Species: *Oocystis lacustris* Chodat (pl.2, fig.23)

[37]609, pl. 1,figs.11;[34]413 ,fig.3, H;[36],pl.2,fig. 20-22)

Elliptical-oval cells, poles rounded smoothly and without thickenings. Chloroplast parietal (1-2), with a pyrenoid. maternal wall globosa. cells 11.5-12 μm long ,6-10 μm in diameter.

Genus:schoederia

Species:Schoederia setigera (pl.2, fig.24)

[37]609, pl. 1,figs.11;[34]413,fig. 4, A)

Elongated- spindle cells, straight or slightly curved, 22-60.5 μm long, 3-6 μm in diameter,with extended poles in long and fine spines. Parietal chloroplast with 1 pyrenoid.

Genus: *Tetraëdron*

Species: *Tetraëdron minimum* (A. Braun) hansgig (pl. 2, fig.25)

[38] 101, pl.5, fig. 124; [30] 267, pl.60, figs. 12-15)

flattened cells, lone front view square, with rounded angles and edges concave; soft cell wall. cells 7.1 μm in diameter.

Species:*Tetraëdron muticum* (A. Braun) Hans. (pl. 2, fig.26)

[30] 267, pl. 60, figs. 16, 17; [39] 234, pl. 1, figs. 13,14).

Cells small, , triangular ,flat, the angles without spines or furcations; sides of the cells emarginate or slightly curved; cells 11.5 μm in diameter.

Family(5) :*Scenedesmaceae*

Genus: Actinastrum

Species:Actinastrum hantzschii Lagerheim (pl. 2, fig.27)

[35] 344, pl. 2, figs. 47; [30]281,pl.64,fig.10,11).

Fusiform or cylindrical form strait toward the top, gather in slimy or compound colonies from 4 or 8 with the length pivot of the cell radiancy of center . cells 3- 5.2 μm in diameter, 16-20 μm long .

Genus: :Crucigenia

Species:Crucigenia lauterbornii Schmidle (pl.2, fig.28)

[30]284,pl.65,fig. 11)

Colony consisting of 4 subspherical cells arranged in 2 opposite pairs about a large square space bounded by the flat ,Inner walls of the cells ; cella in contact only at their inner corners; cells 4–9 μm in diameter, 8 – 13 μm long .

Species:Crucigenia tetrapedia (Kirchner) W.West & G.S.West (pl.2, fig.29)

[31], 61, pl. 1, figs. 21;[36]84,pl.2,fig.30)

4 cells flat, quadratic ,crucified; arranged about aminute central space,triangular cells, outer margins of straight cells;Single parietal chloroplast with 1 pyrenoid. cells 4.3– 8.9 μm in diameter.

Genus: *Scenedesmus*

Species: *Scenedesmus acuminatus* (Lagerhheim) Chodat (pl.2, fig.30)

[31] 62, pl. 1, figs. 23;[30]275,pl.62,fig.16)

Colonies curved of 4-8 (usually 4) fusiform cells with sharp pointed ends. Interior cells forming a flat plate and the other cells lunate and at an angle to the plane of the interior cells; rarely, all the cells in the same plane. Cell wall smooth and without teeth or spines. Cells 18-22 μm long, wide 10-15 μm .

Species: *Scenedesmus arcuatus* (Lemmermann) Lemmermann (pl.2, fig.31)

[40] 77, PL. I, fig. 6, PL. II, fig. 23).

Cells are angularly oblong to ovoid. Colony 8 celled which are arranged in two linear series. Cell wall smooth. Cells are 8.7 μm – 14 μm long and 3.5 μm – 7.5 μm wide.

Species: *Scenedesmus bicaudatus* Dedusenko (pl.2, fig.32) (new recorded)

[40] 79, pl. 1, figs. 3, PL. II, fig. 20 ;[35]354,pl.2,fig.51)

Synonym: *Scenedesmus quadricauda* var. *bicaudata*

Colony 4 celled set in a linear series, long spine there in one pole of terminal cell, spine of one terminal cell appear opposite angle to the other terminal cell; cells 9 μm long and 4 μm broad with 6 μm long spine.

Species: *Scenedesmus bijuga* (Turp.) Lagerheim (pl.2, fig.33)

[30]276, pl. 63, figs.2,7).

Colony consisting of 4-8 cells ,ovate or oblong ,single flat sequence ,none teeth or spine ,cells 4-8 μm in diameter , 10-15 μm long.

Species: *Scenedesmu bijuga* (Turpin) Lagerheim var. *alternans* (Reinsch) Hansgirg (pl.2, fig.34)

[40]80, PL. I, fig. 8, PL. II, fig. 25; [30]277, pl.63, figs.3,4).

Colony 8 celled set in an alternating series, cell ovoid or ellipsoidal with rounded ends. Cells are 10.1– 15 μm long and 4.7 – 7 μm wide.

Species: *Scenedesmus dimorphus* (Turpin) Kützing (pl.2, fig.35)

[30]277, pl.63, figs.8,9).

Colony composed of 4- 8 fusiform cells arranged in a single or alternating series, outer cells are lunate with pointed apices, inner cells with straight ,sharp apices; cells 4–7 μm in diameter, 16-20 μm long .

Species: *Scenedesmus perforatus* Lemmermann (pl.2, fig.36)

[30]279, pl.46, figs.24,25;[40]77,pl.2,fig.32,33).

Colony 4 celled arranged in linear series, inner cell with concave side ,outer cell with convex side, lenticular perforations present between two adjacent cells, long spine present at the pole of terminal cells; cell 20 μm long and 5 –9 μm broad; length of spine 7 μm .

Species:*Scenedesmus quadricauda var. quadrispina* (Chod.) (pl.2, fig.37)

[30]280, pl.63, figs.21;[40]81,PL. I, fig. 4, PL. II, fig. 21;[35] 345 ,pl. 2,fig. 55).

Colonies usually 2-4 cells, ovoidal and about twice as long as wide. Poles of terminal cells with single short curved spine. Cells long 16 µm, breadth 7 µm ;length of spine 4 µm .

Species:*Scenedesmus quadricauda var westii* G.M. Smith (pl.2, fig.38)

[30]281, pl.64, figs.7)

Colony consisting of 4-8 ovate cells ,6.2 µm in diameter,18 µm long and have strongly reflexed short spines.

Division: Euglenophyta

Class: Euglenophyceae

Order: Euglenales

Family: Euglenaceae

Genus: *Euglena*

Species:*Euglena polymorpha* Dang. (pl.2, fig.39)

[41]131, pl.2, figs.17)

Cell fusiform, pellicle flexible, striae delicate, spiral 88-90 µm long, 23-25µm broad, chloroplasts numerous, disc-shaped, margi irregular;1 pyrenoids present.

Species:*Euglena sanguinea* Ehr. (pl.2, fig.40)

[41]131, pl.2, figs.19,20)

Cell broadly fusiform to spindle shaped, pellicle spiral striated; chloroplasts numerous ,with deeply incised lobate margins; ,49-120µm long , 27-35 µm broad.

Species:*Euglena spirogyra* Ehr. var. *spirogyra* (pl.3, fig.41)

[41]132, pl.2, figs.23)

Cell cylindrical, pellicle yellowish 100-150 µm long, 10-20 µm broad; tail piece 10-12µm long, chloroplasts numerous, small disc, paramylon grains 2.

Genus: *Lepocinlis*

Species:*Lepocinlis ovum* (Ehrenb.) Lemmerm (pl.3, fig.42)

[33]225, pl.5, figs.72 ;[32]295,pl.5, fig. 104)

Cells elliptic, posterior end attenuated in a conical caudal process; pellicule with helicoidal stripes; many discoid chloroplasts, two annular, lateral paramylon grains ,22 µm long, 12 µm diam.

Genus: *Phacus*

Species:*Phacus curvicauda* Svirenk (pl.3, fig.43)

[30] 399, Pl. 87, 88; figs. 14, 21)

Cells broadly ovoid in outline, anterior end broadly rounded ,slightly spiral in the posterior part, which is extended into a caudus that curves obliquely to the left; periplast longitudinally finely striated (or smooth); paramylon bodies 2 large discs; chloroplast numerous ovoid bodies; cells 24 µm in diameter, 36 µm long.

Division(3):-pyrophyta

Class(1):cryptophyceae

Genus:cryptomonas

Species:*Cryptomonas erosa* Ehrenb (pl.3, fig.44)

[30]442, Pl.95, figs.39;[32]298,pl.7,fig. ,128,129)

Cell broadly ovate or ellipsoid,the left margin arcuate and more convex than the right,apex almost evenly bilobed ,the gullet broad,extending about 0.5 or less the length of the cell; cells 9-14 µm in diameter, 15-32 µm long.

Class(2) :dinophyceae

Order1:gymnodiniales

Family: :gymnodiniaceae

Genus:Gymnodinium

Species:*Gymnodinium fuscum* (pl.3, fig.45)

[30]426, pl.89, figs.23).

Cells ovoid , large , epicone like dome and hypocone as broad as the epicone ,narrowed posteriorly to form an inverted cone with a slightly produced tip; transverse groove slightly spiral ; the longitudinal furrow extending about half way into the hypocone,but scarcely at all into the epicone. cells 50-65µm in diameter 90-100µm long.

Order(2): *Peridinales*

Family: *Peridiniaceae*

Genus: *Peridinium*

Species:*Peridinium gatunense* Nygaard (pl.3, fig.46)

[30]433, pl.90, figs.25,26).

Cells elliptic to globose, with angulations in the marginal sutures ; the poles broadly rounded ; transverse channel spiral with a wide border , unequally dividing the cell in to a greater epicone and a shorter hypocone ; the longitudinal channel extending wide , striated sutures between them , epitheca with 13 plates ; hypotheca with to large antapicals and 5 posteingular plates cells 50 -82 µm in diameter, 30 -75 µm long .

Division(3):- Cyanophyta

Class : Cyanophyceae

Order(1) : Chroococcales

Family:chroococcaceae

Genus: *Chroococcus*

Species:*Chroococcus thermalis* (Maneghini) Nageli (pl.3, fig.47) (new recorded)

[45]61, pl.3, figs. 1,2)

Trichomes spiral or circular, short, solitary, slightly arched. Cells cylindrical and usually slightly arched, heterochromes Spherical to oval, are usually arranged two by two at each end of the filament. Akinetes oval, are arranged in half of the trichomes, separated from the heterocysts. Diameter cellular of 4-6 μm and length of 4.5-9.5 μm diameter of trichom 10-52 μm .

Species:*Anabaenopsis elenkinii* V.V. (pl.3, fig.53)

[45]61, pl.3, figs.3,4;[30]520, pl.131,fig.4)

Trichome : circular, short and solitary, cylindrical cells with extremities rounded, contain spherical terminal heterocytes with 4-6 μm in diameter. Akinetes broadly ovoid, 8-10.5 μm in diameter.

Genus: *Cylindrospermopsis*

Species:*Cylindrospermopsis taveriae* Komárek (pl.3, fig.54) (new recorded)

[45]63, pl.3, figs.11,12)

solitary trichomes in circular, spirals or more or less irregular. Cylindrical or slightly barrel cells, small, tapering apical cells and usually slightly narrower and round at the apex. The heterocyste is slightly elongated, conical, curved, and rounded at apex. Cell diameter 1.53 μm and 3 μm long.

Family: Borziaceae

Genus: *Komvophoron*

Species *Komvophoron constrictum* (Szafer) (pl.3, fig.55) (new recorded)

[43] 145, pl.3, figs.c).

Trichomes in a straight line, 5-6 μm wide, not attenuated towards the end, constricted at the cross-walls, cells 2-4 μm wide, slightly thin at the middle, apical cells rounded.

Species:*Komvophoron minutum* (Skuja) (pl.3, fig.56) (new recorded)

[33]217, pl. 2 ,fig. 14)

Trichomes straight or solitary, slightly curved, constricted; cells longer than broad, 4.5-7 μm long, 3.1 -4 μm wide;

apical cell attenuated, not capitated; cell content blue-green, homogeneous. Length of the trichome of 38-100 μm .

Family:oscillatoriaceae

Genus: *Lyngbya*

Species:*Lyngbya martensiana* Meneghini (pl.3, fig.57)

[46]335,pl.2,fig.18)

Filaments solitary, straight, 8.0-13 μm wide; sheaths hyaline, thick, colorless to yellowish, lamellate; trichomes not attenuated, not constricted at the granulated cross-walls,5.5-9.7 μm wide; cells 0.2- 0.5 times longer than wide, 2.0-4.0 μm long; cell content blue-green; apical cell rounded.

Genus: *Oscillatoria*

Species:*Oscillatoria anguina* Bory (pl.3, fig.58)

[46]335, pl. 2, figs.19,20).

Trichomes solitary, curved, straight and gradually tightening at the apex, not constricted at the granulated cross-walls, 6 -9.3 μm wide; cells 0.4-0.5 times longer than wide, 1.2 -3.1 μm long; apical cell capitate or rounded, with a thick outer cell wall.

Species:*Oscillatoria curviceps* Agardh (pl.3, fig 59)

[46]335, pl. 2, figs.21).

Trichomes solitary, curved, straight and gradually tightening at the apex, not constricted at their granulated cross-walls, 9.0-16.0 μm wide; cells 0.1-0.4 times longer than wide, 1.7-3 μm long; cell content blue green; apical cell capitate or rounded, with thick outercell wall.

Species:*Oscillatoria limosa* (Roth) Agradh (pl.3, fig.60)

[43]142,pl.3, fig.d,e;[44] 206, p. 1-42, fig. 11)

Trichomes straight 12-17 μm broad, cells 3-4 μm long with mostly finely granular not constricted at the granulated cross-walls, not attenuated at the ends, apical cells flat-rounded or rounded with slightly thickened outer cell wall, without calyptra.

Species:*Oscillatoria princeps* Vaucher (pl.4, fig.61)

[43]142,pl.3, fig.g;[46]336,pl.2,fig. 23)

Trichomes straight, apical cells rounded , with thickened cell wall , not constricted at cross-walls,20-24 μm wide. Cells always shorter than wide, 3-5 μm long. Apical cells rounded , with thickened cell wall.

Species:*Oscillatoria splendida* Greville (pl.4, fig.62)

[30]491,pl.110, fig.5-7)

Trichomes solitary, straight or curved,tapering for a long distance to a fine hair at the apex. Apical cell conical and capitate . cells 2–3µm in diameter, 8.5 – 13.1 µm long , not constricted at the cross walls .

Species:*Oscillatoria tenuis* Agardh (pl.4, fig.63)

[44] 222 pl. 42, fig. 15;[46]336,pl.2,fig. 24)

Trichomes solitary, straight or fl exuous,a pical cell rounded. not attenuated, not (or only slightly) constricted at the granulated or ungranulated cross-walls, 6.75-11.5 µm wide; cells up to 0.2-0.74 times longer than wide, 1.6-3 µm long.

Species:*Oscillatoria cf. vizagapatensis* Rao (pl.4, fig.64)

[43]142,pl.3, fig.j)

Trichomes straight, not constricted at the cross walls, slightly attenuated at the ends, cells2.5-3 µm long, 7-11 µm wide, apical cells rounded-conical, without calyptras.

Genus: *Spirulina*

Species:*Spirulina gigantea* Schimidle (pl.4, fig.65)

[43]144,pl.5, fig.j).

Trichome 44 µm long, breadth 3 µm, deep blue green, regularly spirally coiled, at the end conical attenuated, spirals 12-16 µm.

Species:*Spirulina meneghiniana* Zanardini (pl.4, fig.66)

[43]144,pl.5, fig. k).

Trichomes 2 µm wide, with special pore and hole patterns in the cell walls, nearly irregularly loosely screw-like twisting, 3-5 µm wide.

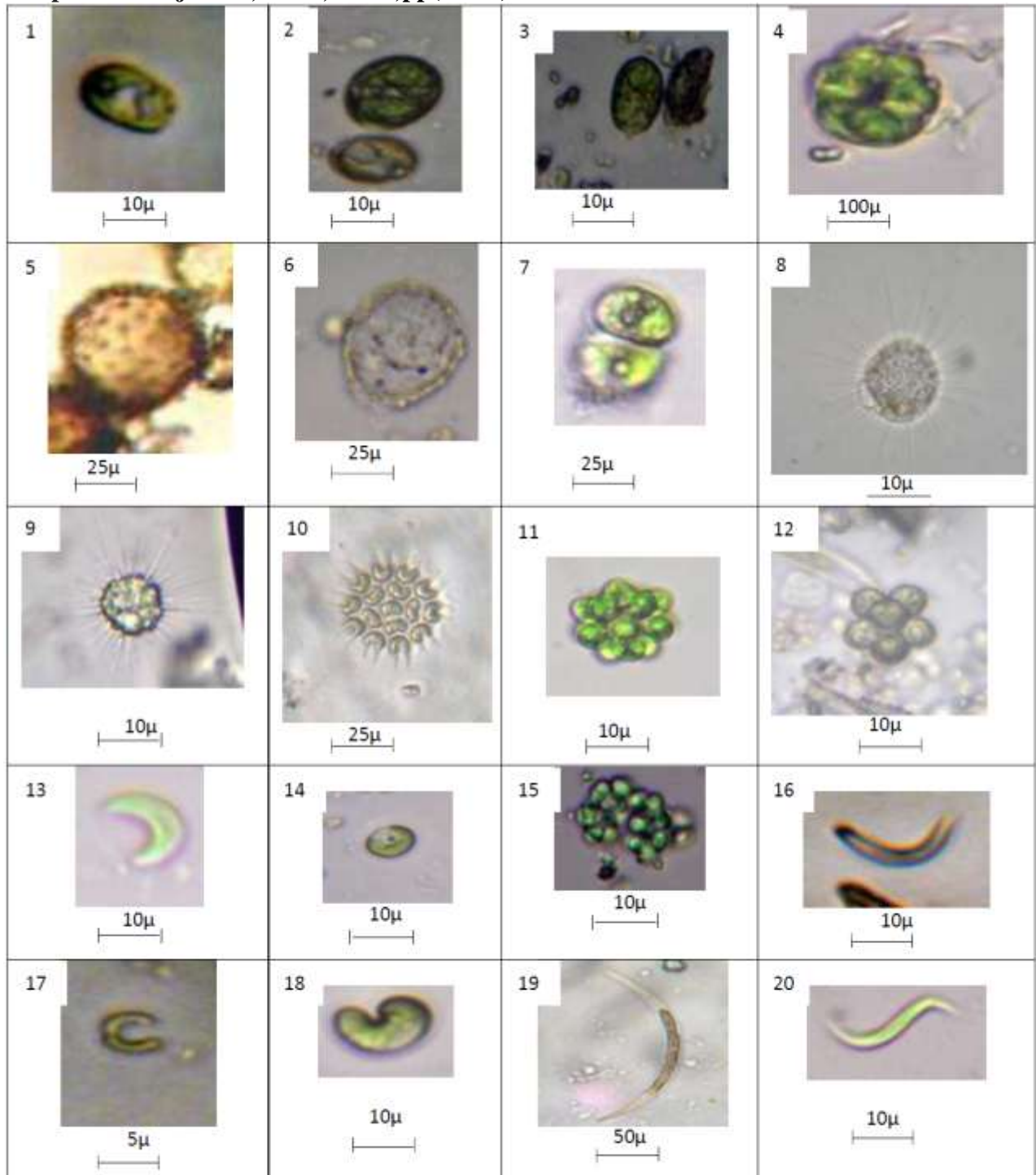


Plate 1

1-*Carteria cordiformis*, 2-*Chlamydomonas angulosa*, 3-*Chlamydomonas globosa*, 4-*pandorina morum*, 5-*Volvox aureus*, 6-*Volvox globator*, 7-*Chlorococcum humicola*, 8-*Golenkinia paucispina*, 9-*Golenkinia radiata*, 10-*Pediastrum boryanum*, 11-*Coelastrum asterioeids*, 12-*Coelastrum microporum*, 13-*Ankistrodesmus bibratianus*, 14-*Chlorella vulgaris*, 15-*Dictyosphaerium tetrachotomum*, 16-*Kirchneriella elongate*, 17-*Kirchneriella microscopica*, 18-*Kirchneriella obese*, 19-*Monoraphidium arcuatum*, 20-*Monoraphidium contortum*

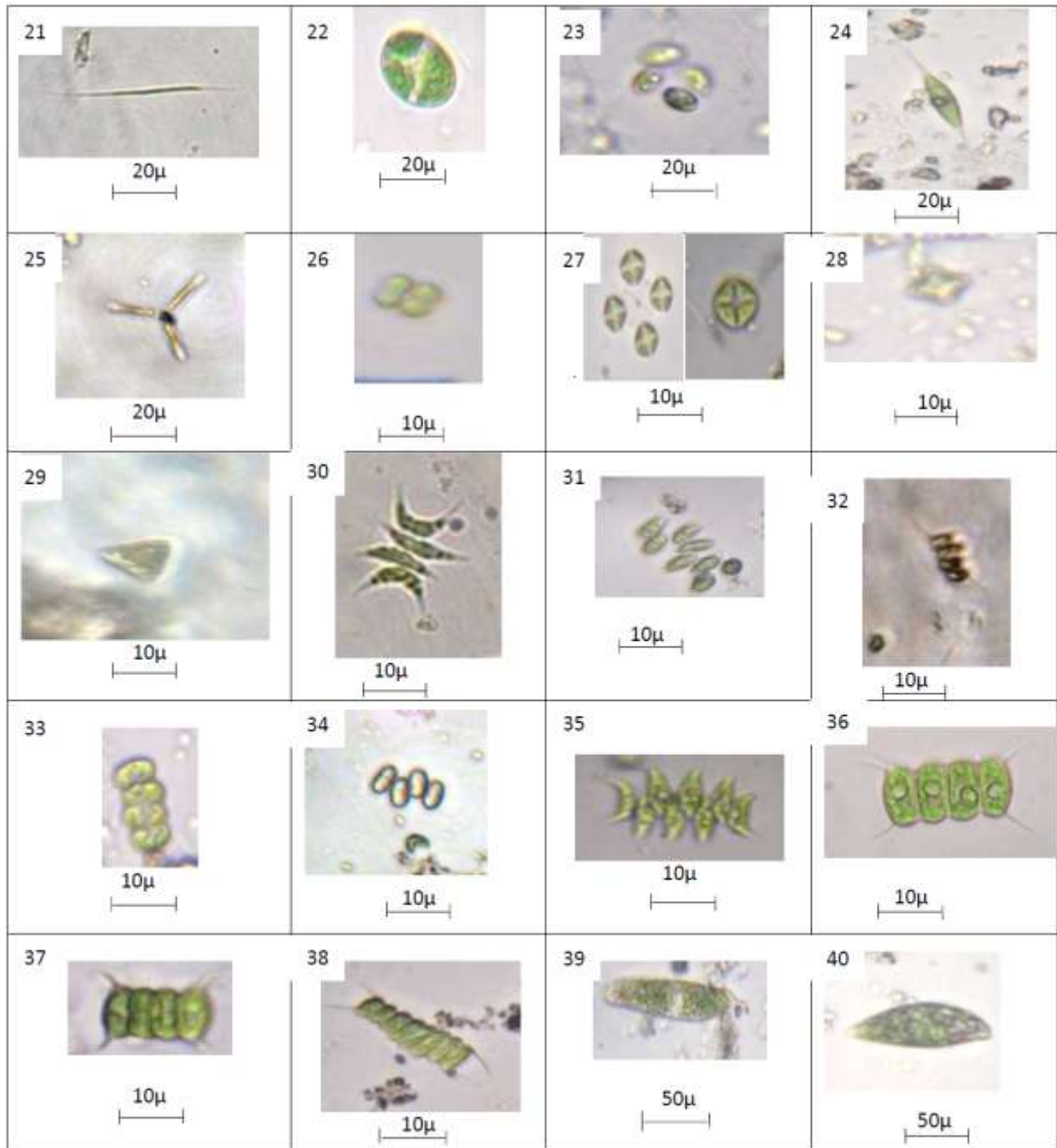


Plate 2

21- *Monoraphidium griffithii*, 22- *Oocystis borgei*, 23- *Oocystis lacustris*, 24- *Schoederia setigera*, 25- *Actinastrum hantzschii*, 26- *Crucigenia lauterbornii*, 27- *Crucigenia tetrapedia*, 28- *Tetraëdron minimum*, 29- *Tetraëdron minimum*, 30- *Scenedesmus acuminatus*, 31- *Scenedesmus arcuatus*, 32- *Scenedesmus bicaudatus*, 33- *Scenedesmus bijuga*, 34 *Scenedesmu bijuga* (Turpin) Lagerheim var. *alternans*, 35- *Scenedesmus dimorphus*, 36- *Scenedesmus perforatus*, 37- *Scenedesmus quadricauda* var. *quadrispina*, 38- *Scenedesmus quadricauda* var *westii*, 39- *Euglena polymorpha*, 40- *Euglena sanguinea*

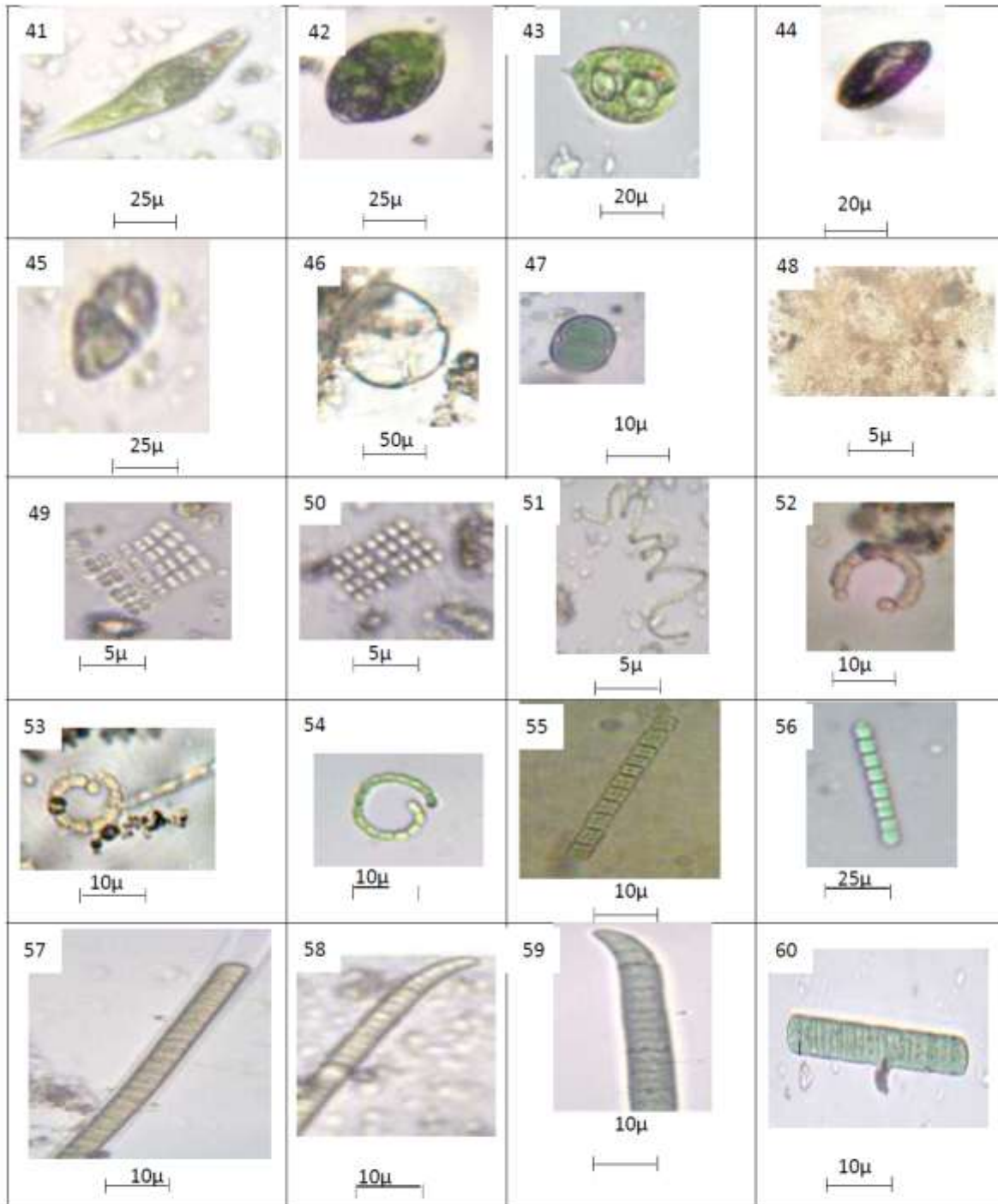
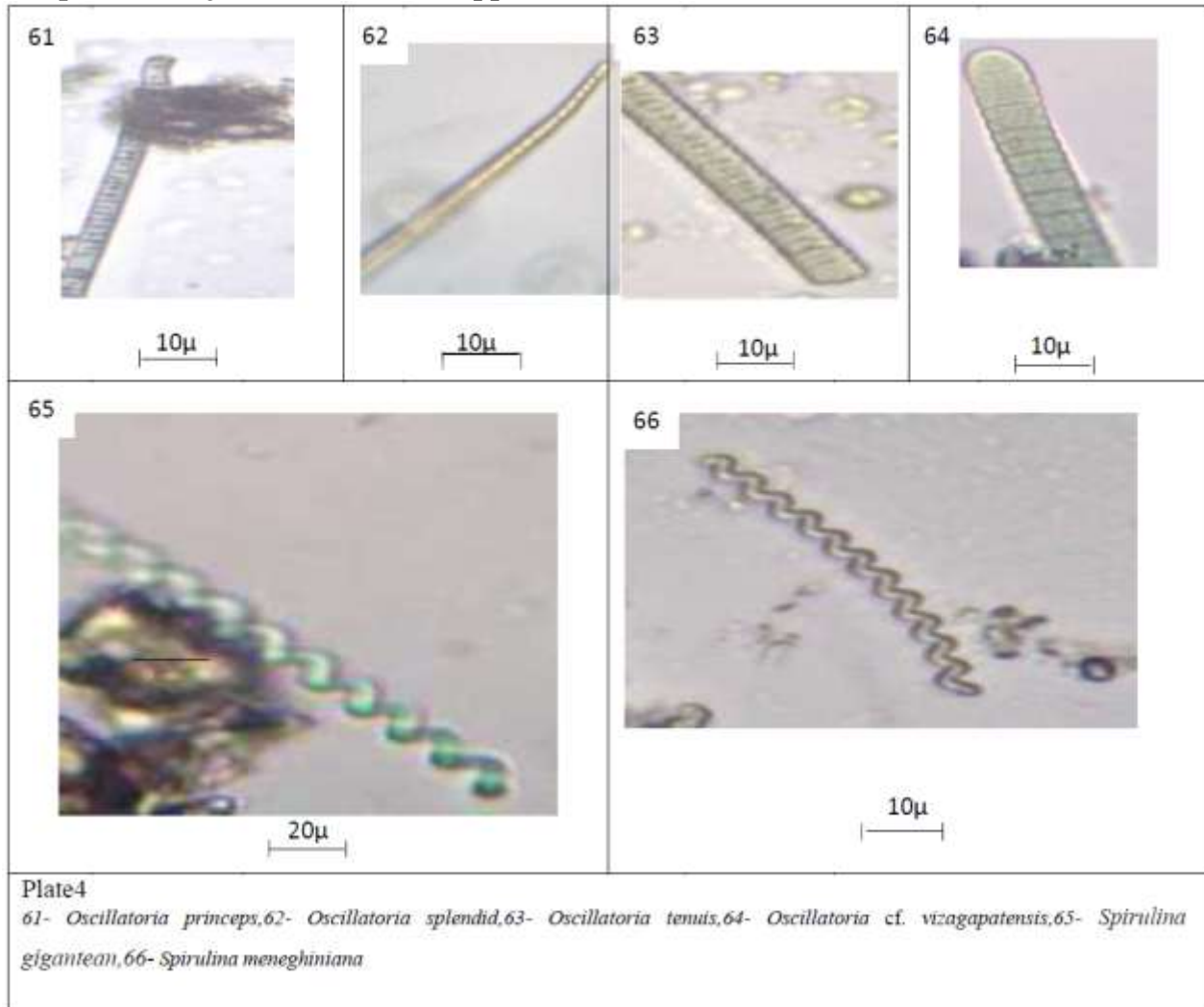


Plate3

41- *Euglena spirogyra* Ehr. var. *spirogyra*, 42- *Lepocinclis ovum*, 43- *Phacus curvicauda*, 44- *Cryptomonas erosa*, 45- *Gymnodinium fuscum*, 46- *Peridinium gatunense*, 47- *Chroococcus thermalis*, 48- *Microcystis aeruginosa*, 49- *Merismopedia elegans*, 50- *Merismopedia punctata*, 51- *Anabaena* cf. *flos-aquae*, 52- *Anabaenopsis circularis*, 53- *Anabaenopsis elenkinii*, 54- *Cylindrospermopsis tavaerae*, 55- *Komvophoron constrictum*, 56- *Komvophoron minutum*, 57- *Lyngbya* cf. *martensiana*, 58- *Oscillatoria angustina*, 59- *Oscillatoria curviceps*, 60- *Oscillatoria limosa*



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