

Studies on Micro-morphology of Chlorophycean species from waterfalls of Courtallam, Tamil Nadu.

M.Selvi¹ and S.Vanitha²

Department of Botany

Sri Parasakthi College for Women, Courtallam-627802

Affiliated to Manonmaniam Sundaranar University, Tirunelveli

Abstract: - The Micro-morphology of fresh water algae is incredibly diverse, encompassing various cell shapes of round, oval, star shaped and spiral. The growth patterns of these species also have, unicellular, filamentous and colonial and cellular structures such as a protective cell wall composed of polysaccharides and glycoproteins and chloroplasts of varying shapes designed for light capture. These features vary significantly between algal groups including green algae, diatoms and cyanobacteria which are crucial for identifying and understanding their ecological role. In this present study, the class chlorophyceae, 164 algal taxa were identified and they fall into 61 genera. All species were specific to particular habitats of Courtallam. Maximum species were *Oedogonium* and *Spirogyra*.

Index Terms: Key words: Freshwater algae, Courtallam and Chlorophyceae.

1. Introduction: -

The algae are a polyphyletic, artificial assemblage of O₂- evolving, photosynthetic that includes seaweeds (macroalgae) and a highly diverse group of micro-organisms known as microalgae. Algae is an aquatic organism of an enormous and diverse group, which has the ability to conduct photosynthesis (Victoria Anand Mary *et al.*, 2018). The phylogenetic diversity of the algae is very broad and is reflected in an equally wide range of metabolisms and biochemical properties. Algae is a commonly used term to denote prokaryotic and eukaryotic oxygen producing photosynthetic organisms that contain chlorophyll a, (Borowitzka, 2018) ranging from microscopic unicellular to multicellular giant organisms such as kelp (Barsanti and Gualtieri, 2022). Approximately 60,000 species are documented in AlgaeBase, with approximately 55,000 of them being eukaryotic algae. Among them, 13,000 species are green algae, including chlorophytes and charophytes (Guiry and Guiry, 2023). Green algae are widespread in inland habitats, but certain groups may have specific ecological requirements. For example, flagellated chlorophytes tend to be more abundant in standing waters are nutrient rich. Coccoid uni cells and colonies are common in the plankton of standing waters and slowly moving rivers when nutrients, light, temperature are reasonably high (Robert G. Sheath and John D. Wehr, 2015).

2. Materials and methods: -

2.1.1 Study Area

In the present study, five sample collection sites (S1 to S5) were selected on Courtallam (Plate: 1 & Plate: 1A). Site S1 is situated at Chitraruvi (8° 55'55"N 77°16'09"E). Site S2 is situated on Tiger falls (8.9298°N, 77.2690°E). Site S3 is situated on Five falls (8.9308°N, 77.2378°E). Site S4 is situated on Old falls (8.9146°N, 77.3082°E). Site S5 is situated on New falls (8.9308°N, 77.2378°E).

2.1.2 Sample Analysis

Samples were collected during a survey in September 2019 to December 2022 from different sites. Samples were collected in glass injection bottles (10ml capacity) which were previously purified in the procedure and rinsed three or four times with autoclaved distilled water. During the collection of samples, extreme care was exercised to avoid any contamination. Micro algae were collected in sampling bottles and 4% formaldehyde was added to preserve the samples. The water samples and sediment samples were cultured in Bold basal medium (Bold and Wynne., 1973) at the ratios of 1:1, 1:5, 1:10, 1:20, 1:50, 1:100, and 1:1000 to get visible colonies.

3. Morphological Description of Micro algae

1. *Characium Sp.*

Unicellular; cell body ellipsoidal or spindle- shaped, attached on a substrate at one end; a single chloroplast plate- like in shape, with a pyrenoid (*C. ambiguum* (Braun) Hermann 1863 (Plate:1). Cells elongate- fusiform or lanceolate; narrowed anteriorly but with a bluntly rounded apex; narrowed below to a long slender stipe, about half the length of the cell body, with a brown basal attaching disc; cells 8-9µm in diameter, 16-18µm long (*C. rabenhorstii* De Toni 1889).

2. *Kitchneriella Sp.*

Colony composed of 16 elongate-cylindrical, spirally twisted, cells having rounded apices, one parietal chloroplast, without a pyrenoid, cells 30-33.7 µm long and 3 µm in diameter (*K. elongata* G.M.Smith 1916; *K. contorta* (Schmidte) Bohlin 1897) (Plate:1). Colonies of 4,8,16 or 32 cells in a gelatinous sheath; cell body long cylindroid, strongly curved or twisted, both ends rounded; a chloroplast full within the cell; a single pyrenoid.

3. *Chlamydomonas sp.* (Ehrenb)1835

Motile unicellular algae. Generally oval or circular. The Cell wall is made up of glycoprotein and non-cellulosic polysaccharides instead of cellulose. Two anteriorly inserted whiplash flagella. Each flagellum originates from a basal granule in the anterior papillate or non-papillate region of the cytoplasm. Each flagellum shows a typical 9+2 arrangement of the component fibrils. Contractile vacuoles are near the bases of flagella. Prominent cup or bowl-shaped chloroplast is present. (*C. reinhardtii*

(Ehrenb) Dangeard, 1888) (Plate:1). *Chlamydomonas reinhardi* is a single-cell green alga about 10 micrometers in diameter that swims with two flagella. It has a cell wall made up of hydroxyproline rich glycoproteins, a larger cup-shaped chloroplast, a large pyrenoid, and an eyespot that senses light.

4. *Oedogonium* sp. Link ex Hirn 1900 (Plate:1).

Filaments are unbranched, composed of cylindrical or capitellate cells. Filaments attached when young (may become free-floating later). Cells enlarged at the anterior end where usually one or two ring-like scars resulting from cell division may be observed. A basal cell is usually modified to form a hold-fast cell; an apical cell is usually broadly rounded or acuminate. Chloroplasts are parietal and net-like, usually with several pyrenoids. Reproduction is both sexual and asexual. Sexual reproduction is oogamous. Sulfatory cells are sometimes inflated. A species may be monoecious or dioecious; macrandrous or nannandrous. Oogonia one to several in each filament; oogonial opening either by a pore or operculum; oospores may be smooth or variously ornamented. *O. pectorum* (Link ex Hirn) Nordstedt. is a freshwater habitat. Filamentous in nature. The mature filaments are free floating. The cell wall is differentiated into inner cellulose and outer pectic layers. The protoplast consists of a single large, reticulate parietal chloroplast with several pyrenoids. There is a single parietal nucleus embedded in the cytoplasm just with a chloroplast. As a root-like holdfast, it contains a netlike chloroplast and a large central vacuole. *O. gracilius* (Wittr.) Tiffany 1934., Macrandrous; dioecious. Vegetative cells are cylindrical, 20-25 µm in diameter, (40)-51-100 µm long. Oogonia solitary; obovoid-globose; opening by a superior pore; 36-42 µm in diameter, 44.4-46- (57) µm long. Oospores globose; nearly filling the oogonia; wall smooth; 33-35- (39) µm in diameter, 33-35- (44) µm long. Antheridia 19-22 µm in diameter, 7-10µm long. *O. hispidum* Nordstedt in Wittrock 1871., Nannandrous; gynandrophore. Vegetative cells are cylindrical, 9-14 µ in diameter, 36-130µ long. Oogonia solitary; terminal; sub ellipsoid or ellipsoid-globose; opening by an inferior pore; 35-44 µ in diameter, 42-56µ long. Oospores globose to globose-ellipsoid; not filling the oogonia; outer wall spiny; 32-39 µ in diameter, 32-40µ long. Antheridia 5-6µ in diameter, 7-9µ long. *O. giganteum* Kuetzing 1845., Macrandrous; dioecious. Vegetative cells are cylindrical, (30)-46-48-(50) µm in diameter, 65-200-(225) µm long. Oogonia solitary; cylindrical- obovoid or ellipsoid; opening by a superior pore; (53)-55-60-(69) µm in diameter, 65-95-(106) µm long. Oospores are ellipsoid; nearly filling the oogonium; a wall of three layers, the middle layer with longitudinal rows of deep pits; (51)-55-65µm in diameter, 90-93-(103) µm long. *O. globosum* (Link ex Hirn) Nordstedt 1878. Multicellular, filamentous. Filaments are unbranched and uniseriate. All cells are cylindrical and alike except basal and apical ones. Cells are slightly swollen at the upper ends. The basal cell acts as a holdfast devoid of chloroplast. Macrandrous, homothallic, vegetative cells cylindrical, 10-14µm x 30-50 µm; oogonium single, obovoid, 26-33µm x 26-36µm, poriferous, pore superior, oospore globose, filling the oogonium, spore wall smooth; antheridia single or in a series, sub epigynous or sub perigynous, 9-13µm x 8-10µm. *O. anomalum* Hirn 1900., Macrandrous; dioecious. Vegetative cells are stout, cylindrical; (37)- 40-50 µm in diameter, 80-85- (300) µm long. Oogonia solitary; subovoid or cylindrical-ovoid; opening by a superior pore; (54)- 56.3-64 µm in diameter, (68)-75-85 µm long. Oospores globose or subglobose; not filling the oogonia; wall of oospore smooth, thick; (48)-54-56- (60) µm in diameter, (52)-54-58- (61) µm long; antheridia 30-40 µm in diameter, 6-18 µm long. *O. nodulosum* Wittrock 1872., Macrandrous; monoecious. Vegetative cells with 2 prominent undulations and constrictions; 20-29 µm in diameter, 30-140 µm long. Oogonia 1 or 2; obovoid- globose or obovoid- ellipsoid; operculate; opening superior; 45-57 µm in diameter, 56-73 µm long. Oospores globose or subglobose-ellipsoid; nearly filling the oogonia; wall smooth; 46-53 µm in diameter, 49-56 µm long. *O. hindustanense* Kamat, 1900., Plants are green, macrandrous, dioecious; filaments long, sometimes curved; vegetative cells rectangular, 15-25 µm in diameter and 20-40 µm long; oogonium ovoid, 20-35 µm in diameter and as broad as long. *O. mexicanum* Wittrock 1878., Macrandrous; dioecious. Vegetative cells are cylindrical, 34-41 µm in diameter, 60-140µm long. Oogonia cylindrical-ovoid; opening by a superior pore; 53-63µm in diameter, 76-110 µm long. Oospores cylindrical- ovoid; filling the oogonia; wall smooth; 51-60 µm in diameter, 63-80 µm long. Antheridia 28-35 µm in diameter, 7-17 µm long. *O. pringsheimii* Wittr. In Wittrock et Nordstedt 1859., It is a macrandrous, heterothallic; vegetative cells cylindrical, those of male filaments 12-18 µm in diameter, 54-80 µm long; those of female filaments 10-16 µm in diameter, 38-62 µm long; basal cell elongate, slightly undulate, 14-16 µm broad, 46-104 µm long; oogonium single, subovoid- globose, 32-38 µm in diameter, 36-46 µm long, operculate, division superior; oospore globose, not filling the oogonium, 28-34 µm in diameter, 28-34 µm long; spore wall smooth, brown; antheridia 1-4 seriate, 8-10 µm in diameter, 4-6 µm long; spermatozooids two, division horizontal. *O. crispum* (Hass.) Wittrock 1875., It is a macrandrous, homothallic; vegetative cells cylindrical, 8-13 µm in diameter, 15-37 µm long; basal cell elongate, 12-14 µm in diameter, 28-35 µm long; oogonium single, sub depressed globose, 24-30 µm in diameter, 26-35 µm long, operculate, division superior: oospore globose to sub-depressed globose, filling the oogonia, 20-26 µm in diameter, 20-26 µm long: spore wall smooth, thick, brown; antheridia epigynous or hypogynous, upto 4-seriate, 7-8 µm in diameter, 4-6 µm long; antherozoids two, division horizontal.

5. *Haematococcus* sp. C.A. Agardh 1828

Cells ovoid to ellipsoid, having 2 widely diverging flagella from an anterior papilla; protoplast separated from the wall by a wide envelope of mucilage through which cytoplasmic strands radiate; pigment-spot lateral. Cells frequently appear in a stationary condition in which haematochrome pigment becomes predominant. At least 1 species of the genus has been reported from red snow of alpine and subalpine regions. *Haematococcus pluviialis* Flotow, 1844., (Plate:1) Protoplasts are numerous and very fine. The flagella are unusual in possessing a thin tomentum of fine hairs. Contractile vacuoles are not always present and if present they are inconspicuous. The plastid varies in the different species and the number of pyrenoids ranges from many in this species. Small biciliate gametes can be formed, gametes are produced only rarely and never from motile cells.

6. *Eudorina* sp. Ehrenberg 1823b

Eudorina is a paraphyletic genus (Plate:1) in the volvocine green algae clade. A free swimming ovate, obovoid or globose colony, in which 16-32-64 ovoid or ovate cells are enclosed within a gelatinous envelope; 2 long Colonies flagella present which diverge widely beyond the periphery of the colonial envelope; cells often with 1 or 2 anterior beaks or papillae where the flagella arise; 2 minute contractile vacuoles at the base of the flagella. Chloroplast cup- shaped and parietal, with one to several pyrenoids.

7. *Pandorina sp. Bory 1824*

Colony spherical, motile with 4-8-16-32, cells mutually compressed in the periphery of colony, hyaline envelope; biflagellate (Plate:1). The cells are ovoid or slightly narrowed at one end to appear keystone or pear-shaped. Each cell has two flagella with two contractile vacuoles at their base, an eyespot, and a large cup-shaped chloroplast with at least one pyrenoid.

8. *Asteromonas sp. Artari, 1913*

Asteromonas is a single-celled, motile organism. Two flagella extend from the anterior end of the cell. The cells are cone-shaped and have four to eight longitudinal projections, or ribs; when viewed from the pole they are therefore shaped like a four to eight pointed star. Cells lack cell walls but a periplast is present, made of crystalline glycoprotein. Contractile vacuoles are present. Cells are uninucleate and have a single chloroplast filling the cell, sometimes with a pyrenoid, and one stigma. *A. gracilis* Artari 1913., (Plate:1) Unicellular planktonic chlorophyte without a cell wall (naked). Fusiform shape, which is sometimes narrow and sometimes rot; 2 flagella attached to their upper part, absence of cell wall, 3-6 “notches”, running lengthwise laterally throughout the cell, length of flagella equal to 1/2 to 2 times the length of the thallus, average length $18.84 \pm 2.88 \mu\text{m}$ along the long axis and $13.09 \pm 2.4 \mu\text{m}$ along the width and with extreme sizes of 12-22 μm along the long axis and 8.7-16.36 μm across.

9. *Bulbochaete sp. (Agardh) 1817*

Uniseriate filaments with extensive unilateral branching; usually attached to substratum by differentiated holdfast cells (Plate:1). Vegetative cells are uninucleate, highly vacuolate, and with a large reticulate, partial chloroplast containing one to many (usually) pyrenoids. Pyrenoid matrix penetrated by numerous, branched, cytoplasmic channels. Vegetative filaments with cells of two morphological types 1) basal holdfast cells, 2) nearly cylindrical intercalary cells, that are often somewhat greater in width at apical end, and 3) smaller, terminal, “hair” cells with bulbous or swollen base and bearing a much elongated, slender, hair-like, cytoplasmic appendage.

10. *Microspora willeana (Thuret) Lagerheim 1889*

Cell wall shows H shape in transverse section, thin, sections scarcely discernible. Cells cylindrical, slightly or not at all constricted at the cross walls; (Plate:2) Filaments very long. Chloroplasts reticulated without pyrenoids. Cell body 10-12 μm in diameter; length 13-18 μm .

11. *Chaetophora attenuata Hazen 1902*

Forming attached, firm, gelatinous globules, 2-5mm in diameter, having radiating, nearly parallel, erect branches from numerous basal, rhizoidal processes (Plate:2). Filaments are usually dichotomously (some-times trichotomous) branched, ending sharply pointed, setiferous cells; branches not fasciculate, but loose and evenly developed from the main axis and much elongated. Cells 5-6.61 μm in diameter, 10.12-11.73 μm long.

12. *Comasiella arcuata var. platydisca (G.M. Smith) E. Hegewald & M. Wolf*

Flat coenobium, formed by four to eight reniform cells with rounded poles, cells arranged in double, alternating series, sheathed with inconspicuous mucilage; outer cells not fully aligned, parietal chloroplast with one pyrenoid (Plate:2). Cells 9.0-13.0 μm long and 4.0-5.0 μm in diameter.

13. *Ankistrodesmus arcuatus Korshikov 1953*

Cells solitary, arched or semi-circular, gradually narrowing to the ends with pointed apices; single parietal chloroplast, without pyrenoids. Cell dimensions 30-45(56) μm in length, 1.5-2.5 μm in width. *A. fusiformis* Corda ex Korsikov 1953., (Plate:2) Coenobia intertwined to crosswise oriented; fusiform shaped cells with the ends tapering to acute apices usually in fasciculate boundaries of 2-4-8 or more, cells 2-4 μm broad and 20-50 μm long.

14. *Tetraedron sp.*

Tetraedron trigonum Hansgirg 1888a., Cells with more markedly concave sides than in the type. Cell membrane smooth. Cells 19-35 μm in diameter, 6-8 μm thick. Spines 6.2-7 μm long. *T. regulare* Kutzing 1845., Tetragonal cells, pyramidal, with sides slightly convex, angles with a blunt stout spine, cells 23.4 μm in diameter with spines. *T. triangulare* Korshikov 1953., (Plate:2) Cells triangular, flat with thick cell walls. Sides slightly concave. Ends broadly with knob-like projection. Cells 14-16 μm in diameter. *T. muticum* (A.Braun) Hansgirg 1888a., Cells small, flat and triangular with the sides slightly concave and angles broadly rounded or truncated. Cell wall smooth. Cells 6-30 μm in diameter.

15. *Volvox sp. 1758*

Volvox is a polyphyletic genus in the volvocine green algae clade. Each mature volvox colony is composed of thousands of cells from two differentiated cell types: numerous flagellate somatic cells and a smaller number of germ cells lacking in some that are embedded in the surface of a hollow sphere or coenobium containing an extracellular matrix made a glycoproteins (Plate:2). Colony spherical composed of from 500 to several thousand cells arranged at the periphery of a gelatinous sphere of homogenous mucilage, each having 2 flagella of equal length.

16. *Hydrodictyon sp. Roth 1800*

Hydrodictyon known as “water net”, has large colonies composed of elongate cells linked in a reticulated, net-like pattern. Each cell is connected at its end walls to two other cells, forming meshes of five or six cells. The colonies can be as large as 4-6 cm wide and 1m long. The cells are coenocytic and multinucleate. Young cells have a single parietal chloroplast with one pyrenoid, while in older cells the chloroplasts become net-like with multiple pyrenoids (Plate:2) . Large vacuoles take up most of the cellular space and push the cytoplasm around the periphery of the cell. *H. reticulatum* (L.) Lagerheim 1883., Colonies reticulate; meshes pentagonal or hexagonal; cells elongate cylindrical, 51.20- 54.86 μm long, 9.14-10.97 μm broad; wall smooth double layered; chloroplast reticulate; multinucleate; pyrenoid many.

17. *Pediastrum duplex Meyen 1829*

Colonies free floating, flat, circular to oval plate, ellipsoidal one cell thick, 4-64(-128) cells. 15-400 μm in diameter. If 16 or more cells, cells tend to be in concentric rings, each ring, with definite number of cells, disk continuous or with perforations between cells. Marginal cells similar or with two horn-like processes. Cell walls smooth, finally reticulate or highly granules. Inner cells are typically polyhedral with four to many sides. Marginal cells 7-24 μm long, 6-22 μm in diameter. Inner cells 5-24 μm long, 5-27 μm in diameter. *P. duplex var. clathratum* (A.Braun) Lagerheim 1882., (Plate:2) Cells with more deeply emarginate and larger

intercellular spaces. Outer cells with two long stout processes, inner cells without processes. Colonies 8-64 celled. 8- celled colony 44.5 µm in diameter. Cells 11.2 µm in diameter. 12.0 µm long. *P. simplex* Meyen 1897., Colonies circular to oval, of 4-8-16-32 or more cells. Inner side of marginal cells nearly straight, outer side produced into a gradually tapering process, sides concave. Inner cells are polygonal. Cells in contact with adjacent ones and usually without intercellular spaces. When present, intercellular spaces are very small and few in number. Cell wall smooth or punctate to granulate. Cells 4-5.82 µm broad, 14-18.5 µm long. *P. boryanum* (Turpin) 1840., Coenobia 16-32-64 celled and more, coenobia 120-214 µm in diameter, inner cells four concerned with a small lens-shaped perforation in front and another at the back, marginal cells slightly longer than broad, lateral cells in contact along one third the length, processes of marginal cells ending in short spines; chloroplast single, parietal with a pyrenoid; cells 12-15µm broad and 15-25µm long. *P. ovatum* Ehrenberg., Colonies flat 8 cells, 45.36- 47.49 µm broad; peripheral cells, 15.17-18.53 µm long, 10.32-12.63 µm broad without perforation; central cell 1, 7.49-9.25 µm broad; marginal cells convex with single projection; cell wall smooth; chloroplast parietal shape; pyrenoid absent.

18. *Selenastrum sp.* Reinsch 1867

Free-floating colonies made up of 4-8-16 cells usually without an outer mucilaginous envelope. Sometimes, several groups joined together to form larger colonies containing as many as 100 or more cells. Cells semilunar, acicular or spirally twisted, joined to each other by their convex sides, rarely free. Ends usually acutely pointed, rarely bifid. Chloroplast single, parietal, filling the cell and usually with a pyrenoid. Reproduction by the formation of 4-8-16 autospores from each cell which on liberation arrange themselves as in the mother colony. *S. gracile* Reinsch 1867., (Plate:2) Cells lunate to be sickle shaped, quite narrow in proportion to their length apices of the cells sharply pointed, chloroplast parietal without pyrenoid. Cells 2.6-2.7 µm in diameter and 23.6-27.3 µm in length. *S. bibrainum* Reinsh 1866., Cells crescent to sickle shaped with sharply pointed ends and in colonies of 4-8-16 or more cells. Chloroplast single, parietal and usually with a pyrenoid. Cells 5-8µm broad, 16-38µm long.

19. *Desmodesmus sp.*

Desmodesmus abundans (Krichner) Hegewald, 2000., Colonies of 2-4 cells arranging linearly; cell body ovoid or ellipsoidal in shape; outer cells with long spines at both ends and short spines at outer side; inner cells have a short spine at both ends. Cell size 9-20 x 3-5 µm. Cells 6-15 µm broad. *D. dispar* Brebisson, 1868., (Plate:2) Coenobia of 4 slightly alternately arranged and tightly packed cells, cells 17 µm long, 5 µm wide, elongate-ovoid, tapering to rounded or polygonal apices bearing 2 short spines, with spines arising laterally on apices and diagonally opposite on adjacent cells and lying almost perpendicular to long axis of coenobia, spines on adjacent cells often facing in opposite direction., *D. multivariabilis* Hegewald, Antal Schmidt, Braband & Tsarenko, 2005., *Desmodesmus* consists of colonies of two, four, eight or 16 cells arranged in a row. Cells are ellipsoidal to ovoid, joined to each other by their longer sides. The terminal cells of a colony are usually armed with spines. Cell walls may also be covered in ridges, warts, and net-like structures. Cells contain one parietal chloroplast, containing one pyrenoid.

20. *Monoraphidium sp.*

Single cells, fusiform, cylindrical, longer than broad, straight, curved or sigmoid, sometimes spiral, gradually tapered towards the apex, which may be tapered or rounded; smooth cell wall; parietal chloroplast, without pyrenoids. Reproduction by 4-8 autospores, arranged in series within the mother cell, which are released after breaking up the wall of the mother cell into two parts (Comas 1996). *Monoraphidium circinale* (Nygaard) Nygaard 1979., (Plate:2) Cells solitary, fusiform, arched in semi-circles, in viewed sideways, are in the contour spherical; slightly tapered at the ends; single parietal chloroplast without pyrenoids. Cell dimensions: 4.5-10.5 µm in length, 1.5-2 µm in width.

21. *Coelastrum intermedium* (Bohlin) West

Colony spherical, 62-67.5 µm in diameter, 32 celled; cells 15-17.5 µm in diameter, middle cells spherical, peripheral cells sub-spherical with slightly thick projections (Plate:2) .

22. *Palmellococcus saccharophilus* (Krueger) Chodat, 1894

Cells are ellipsoid, ovoid or rarely spherical, bean shaped or pear shaped. Cell membrane thin, colorless and slimy. Chromatophore in the form of a flat and devoid of a pyrenoid (Plate:2) .

23. *Acutodesmus obliquus* (Turpin) Hegewald & Hanagata, 2000

Colony 4 celled, cells fusiform and erect or outer slightly concave. Cells 2-4 µm broad and 18-20 µm long (Plate:3).

24. *Gongrosira fluminensis* Kutzing, 1843

An attached, branched thallus with pseudoparenchymatous, prostrate, and entangled branches giving rise to short, erect filaments terminating in enlarged cells. Growing on wood and old shells; sometimes with rhizoidal branches penetrating the substrate. Cells cylindrical or claviform, with thick, sometimes lamellated walls. Chloroplast 1, a parietal plate with 1 to several pyrenoids (Plate:3)

25. *Tetraspora gelatinosa* (Vaucher.) Desvaux 1818

Thallus at first an attached cylindrical sac, later becoming bullet and lobed but not perforated. Cells irregularly arranged in old plants and differ in size, 2.5-13 µm in diameter (Plate:3) .

26. *Stigeoclonium tenue* (C.A. Agardh) 1843

Thallus heterotrichous, prostrate and erect system well developed; erect filaments sparingly diffuse; prostrate filaments anchors the thallus; branch opposite with pointed end; gelatinous sheath absent; rhizoids absent; apices tapering to setae; hairs multicellular; main axis, 14.48-17.48 µm long, 7.86-8.17 µm broad; (Plate:3) cells cylindrical slightly swollen, constricted at cross wall, 13.97-17.28 µm long, 7.24-9.78 µm broad; chloroplast parietal; pyrenoids 4-7.

27. *Chlorococcum sp.*

C. infusionum (Schrank) Meneghini, 1842., Spherical cells with a diameter of 10-13 µm, solitary but sometimes several cells from a cluster of greenish cells, parietal chloroplasts with a single pyrenoid covering the cells. *C. humicola* (Nageli) Robenhorst 1868., (Plate:3) Cells spherical, solitary or number of cells crowded together to form a stratum; chloroplast a hollow sphere with a lateral notch, cells 6-25µm in diameter, zoospores elliptical, 4.5 µm broad and 3-4 µm long.

28. Scenedesmus sp.

S. incrassatus Bohlin 1897., Single celled or in colonies of 2-4 cells. Cells in a linear or sub alternating series, fusiform, curved with the outer side convex and the inner side more or less straight or slightly concave. Ends of cells stumpy and with apical nodules. Cells 5-10 µm broad and 12-28µm long. *S. quadricauda* Brebisson 1926., (Plate:3) Coenobia 4 celled, cells 16.1µm long and 4.6µm broad, obtuse end, short spines are present on both the poles of the terminal cells, cells cylindrical. *S. bijugatus* var. *graevenitzii* (C. Bernard) Philipose, 1967., Coenobia 4 celled, flat, cells arranged in a linear series, cells oblong-ellipsoid to ovoid with the ends broadly rounded, cells 7-8µm long and 2µm broad. *S. dimorphous* (Turpin) Kützing 1833., Colonies 7-8 celled, with the cells arranged in linear way, outer cells more or less lunate with the apices attenuated, cells 10-11 µm long and 2-4 µm broad. *S. arcuatus* var. *capitatus* Lemmerman 1918., Colonies are usually eight-celled, rarely 4 or 16 celled, curved and with small intercellular spaces. Cells in eight-celled colonies in two series, oblong-ovoid, sometimes slightly angular at the base due to mutual pressure. Cell wall smooth, without teeth or spines. Cells 3.5-4.55 µm broad, 8.4-12.08µm long, Four-celled colony. *S. ginzbergeri* Kammerer 1938 Coenobia is usually 8-celled, rarely 4-celled, with cells linearly to slightly alternately arranged in one row, 15-33 µm long, without a mucilaginous envelope. Cells irregularly spindle-shaped, inner cell straight, outer cells slightly curved, with acute ends, 15-22 x 2-3.5 µm. Cell wall smooth. *S. graevenitzii* (Bernard) Chodat 1926., Coenobia 2-4-8 (generally 4 and 8 celled), enclosed by hyaline gelatinous envelope, cells of 4-celled coenobia arranged in cruciate series, cells of 8-celled coenobia arranged in alternative double series; cells ovate or elliptical, in each pole with a single nodular thickening, 6-17 µm x 3-9 µm in size. *S. quadricauda* var. *longispina* (Chodat) G.M. Smith 1916a., Colonies usually 2-4 celled, rarely 8-celled. Cells ovoid to cylindrical with the cells narrower than in the type and the spines proportionately longer, compared to the length of the cells. Internal cells sometimes have very short delicate spines from some of their poles. Cells 2.5-5µm broad, 8-15.3µm long. Spines 7.5-15µm long. *S. quadricauda* var. *quadrispina* (Chodat) G.M. Smith 1916a., Colonies are usually 2-4 celled. Cells are broadly ovoid and about twice as long as broad. Poles of terminal cells with a single short recurved spine. Cells 3.5-8.5µm broad, 8.5-15-19µm long. Spines 2.5-5.5 µm long. *S. quadricauda* var. *Westii* G.M. Smith 1916a., Colony composed of 4-8 oval cells with small spines. Diameter 4-7 µm, 8-15 µm long and 2-3 µm long spines. *S. denticulatus* Lagerheim 1882., (Plate:3) Colonies usually four celled with the cells arranged in a cruciate to sub alternating manner. Cells ovoid- oblong to ellipsoid with 1-4 teeth from each pole. Teeth are sometimes absent from one end of the inner cells. Cell membrane is somewhat thick. Cells 4-11 µm broad and 6-17 µm long.

29. Quadrigula lacustris (Chod.) G.M. Smith 1920

A free-floating, fusiform-shaped colony containing many short, fusiform cells, mostly arranged in pairs; (Plate:3) cells straight, but with slightly convex margins, tapering to blunt points; chloroplast a parietal plate, sometimes twisted in the cell, without a median notch, with 1 pyrenoid; cells 3-5 µm in diameter, 20-25 µm long.

30. Microglena Sp.

M. coccifera (Goroschankin) Demchenko, Mikhailiuk & Proschold, 2012., (Plate:3) Cell shape wide, ellipsoid; cells (16)22-24(27) µm in diameter and 19-23(27) µm long; cell wall thick with large, broad; papilla trapezoid; chloroplast 3 cup-shaped; pyrenoid 1 to 4-5 (8); widely ellipsoid or spherical surrounded by many small starch grains; stigma bright, rod-like to fusiform in anterior medial position; nucleus at central position; flagellum as long as the cell; two apical vacuoles are present; 2-4 zoospores are produced in asexual reproduction; sexual reproduction anisogamy. *M. basinucleata* Ehrenberg, 1832., Cell shape ellipsoid to wide ellipsoid; cells 25-22 µm in diameter and 12-20 µm long; cell wall thick with large, broad; papilla II trapezoid; chloroplast 2, cup-shaped; pyrenoid half ring-shaped without starch grains; stigma bright, elongated in anterior-medial position; ; nucleus basal position; flagella as long as the cell; two apical contractile vacuoles are present; 2-4 zoospores are produced in asexual reproduction. *M. charkoviensis* Ehrenberg, 1832., (Plate:3) Cell shape ellipsoid to wide ellipsoid; cells 10-16.5 µm in diameter and 8-14.5 µm long; cell wall thick with large, broad; papilla I trapezoid; chloroplast 1 cup-shaped; pyrenoid widely ellipsoid surrounded by many small starch grains; stigma bright, rod-like to fusiform in anterior-medial position; nucleus central position; flagella as long as the cell; two apical contractile vacuoles are present; 2-4 zoospores are present in asexual reproduction.

31. Phycopeltis sp. Millardet 1870.

Dichotomously branched filaments forming openly- branched to pseudoparenchymatous discoidal thalli up to 7 mm diameter. Often golden-brown, orange or orange-red in color (Plate:3) .

32. Ulothrix Sp.,

U. cylindricum Prescott 1944., (Plate:3) Filaments are long, curved, and lightly entangled. Cells elongate-cylindrical, 11-12.5 µm in diameter, 2.25-3 times longer than wide; the wall thin and not constricted at the joints. Chloroplast is a broad band, nearly equal to the cell in length and folded around ¾ of the circumference; pyrenoids 2-5. *U. subconstricta* G.S. West 1915., Filaments planktonic, composed of slightly inflated cells, which are moderately constricted at the cross walls and sometimes enclosed in a gelatinous sheath. Chloroplast is a parietal plate extending through about 2/3 of the median region of the cell, sometimes with a pyrenoid. Cells 5.7-9 µm in diameter, 10-36 µm long. *U. variabilis* Kützing 1849., Filaments long, entangled; cells cylindrical without constriction, 14.63-15.47 µm long, 4.56-6.18 µm broad; cell wall thin; chloroplast parietal-plate not complete circular in mid region; pyrenoids 6-7; nucleus 1. *U. zonata* (Weber & Mohr) Kützing 1833., Vegetative cell cylindrical or swollen, 11-45 x 10-100µm; cell wall thick at maturity; usually a median band with several large pyrenoids. Filaments unbranched attached by modified basal cell; chloroplast band shaped, complete circular in mid region; pyrenoids 6-8; nucleus 1.

33. Cladophora sp.

C. glomerata (Linnaeus) Kuzin, 1843t., (Plate:3) Thallus filamentous, branched, branches making acute angle with the axes; apical cell bluntly rounded, cells 250µm long and 20-60µm broad. *C. oligoclona* Kuetzing 1845., Floating or attached; thallus little branched, the branches opposite or dichotomous, the secondary branches bearing many alternate or unilaterally disposed, clavate or thorn-like 1-celled branches. Cells in the main axis are cylindrical, 45-55 µm in diameter, 2-6 times the diameter in length; branches of the first order 30-40 µm in diameter, the cells cylindrical, up to 10 times the diameter in length.

34. Rhizoclonium sp.

R. hieroglyphicum (C.A. Agardh.) Kützing, 1845., (Plate:4) Filaments wiry, unbranched; septa unconstructed; cell wall thin, 1.87- 2.96 µm broad; lamination absent; cell cylindrical, 277.97-321.86 µm long, 41.44-43.89 µm broad; chloroplast parietal

reticulate; nucleus 7-8; pyrenoids 4-8. *R. tortuosum* (Dillwyn) Kutzing, 1845., Epiphytic on mangrove plant, filaments slender, contorted, forming mats, cells of filaments are 18-30µm in diameter almost equal or one and a half times as long as broad, just before divisions 2-3 times as long, cell wall fairly thick, distinctly stratified. *R. ramosum* Z. Zhao and G. Liu, 1843., Freshwater alga, green, slender, and soft, attached to the surfaces of rocks. Thalli clustered, about 1-2.5 cm long. True branches present from the basal region to the apical parts, laterally inserted, and often deflected from the axis. Thallus is attached using simple basal rhizoids, with chloroplasts sometimes absent or uneven and often one cell long, or longer. Long unbranched filaments growing by intercalary cell divisions. Cells cylindrical, 15.3-52.8 µm in diameter with a length/diameter (L/D) ratio of 1.3-5.8. Chloroplasts are parietal and arranged in a reticulate pattern. *R. riparium*(Roth) Harvey 1849., Plants uniseriate, unbranched; yellowish-green to green, on drying to olive-green, the filaments curled; entangled thin mats or strands, up to 30 cm long, sometimes twisted with numerous short filaments, tapering, irregular rhizoidal branches, composed of 2-5 cells. The cells are cylindrical, 10-20 µm in diameter, 3-5 times as long as diameter and cell walls 2 µm thick; chloroplast coarsely reticulate with numerous pyrenoids.

35. *Spirogyra* sp.

S. elliptica C.C.Jao 1935., (Plate:4) It is a filament, cells are cylindrical, the chloroplasts are 1-16, spirally arranged, parietal ribbon like bodies with numerous prominent pyrenoids. The nucleus is centrally situated in a protoplasmic stand conjugation scalar form or lateral. *S. gracilis* (Hassal) Kutzing 1849., (Plate:4) Vegetative cell 25-30µm broad and 50-100µm long, end wall plain; chloroplast 1 making 1-2 turns; conjugation scalariform, tubes formed by both gametangia; zygospores ellipsoid with rounded ends, 25-35 µm broad and 50-65µm in long; spore wall smooth. *S. decimina* (Muller) Kutzing, 1843., Vegetative cells 55.5-105µm long, 37-42 µm broad, with plane end walls; chloroplasts 2-3, 1-2 turns, conjugation scalariform, tubes formed by both gametangia; empty cells 55-70 µm long, 37.5 µm broad; fruiting cells slightly inflated, 98-102 µm long, 48-53 µm broad; zygospores ovoid to globose, 58-60 µm long, 35-38 µm broad; median spore wall smooth, yellow. *S. iyengari* Link, 1820., (Plate:4) It has cylindrical cells that are joined end to end to form an unbranched filament. The cell walls are firm and have a thin film of mucilage on the outside, giving them a slimy feel. Chloroplasts have a helical shape and there can be up to 15 per cell. Numerous pyrenoids are present. The nucleus, often visible in live material, is in the centre of the cell. Cells may be between 10 and 160µm in diameter and up to 590 µm long. Filaments fragment easily at the cross walls, each fragment growing into a new filament. *S. fluviatilis* Hilse 1862., Vegetative cell cylindrical, 20-60µm broad and 40-192 µm long, cross wall plain; chloroplasts 2-3 making 2-2.5 turn, pyrenoids distinct; conjugation scalariform, conjugation tubes formed by both gametangia, zygospores oval, ellipsoidal, 20-30 µm broad and 40-60 µm long, spore wall smooth and dark. *S. varians* (Hassal) Kuetzing 1843., Filaments of short cells, (28)-33-(40) µm in diameter, 51-85-(120) µm long, with plane end walls; chloroplast solitary, making ½-4 turns. Conjugation by tubes from both gametangia; fertile cells inflated on the conjugation side only. Zygospores are ellipsoid or ovate-ellipsoid; median spore wall smooth; 32-40 µm in diameter, 50-63-(100) µm long. *S. platensis* Transeau, 1914., (Plate:4) Vegetative cells 100-135µm long, 18-20 µm broad, with plane end walls; chloroplast 1 (rarely 2), 1-8 turns; conjugation scalariform and lateral, tubes formed by both gametangia; empty cells 105-120 µm long, 20µm broad; fruiting cells fusiform-inflated, 95µm long, 38-42 µm broad; sterile cells cylindrical; zygospores usually ellipsoid, sometimes ovoid or cylindrical ovoid, 56 µm long, 29 µm broad; median spore wall smooth, yellow. *S. dentireticulata* Jao, 1935., Spore membrane yellow-brown, reticulate with coarse ridges; ovoid zygospore 30-34 x 70-76 µm. End wall replicate; vegetative cell replicate transverse wall and single chloroplast; ladder-like conjugation; gametangia slightly enlarged; 4-5 turns per cell, width 20-24 µm, length 200-340 µm. *S. mirabilis* (Hassal) Kuetzing 1849., Filaments of slender cells, 24-26-(27) µm in diameter and up to 10 times the diameter in length, with plane end walls; chloroplast solitary, making 4-7 turns. Conjugation by tubes from both gametangia; fertile cells inflated. Zygospores ovate to ellipsoid; median spore wall smooth and brown; 24-29 µm in diameter, 50-83 µm long. *S. punctata* Jao, 1935., Spore membrane yellow-brown and punctate; plane transverse wall, ellipsoid zygospore 31-34 x 54-65 µm; ladder-like conjugation; gametangia inflated, chloroplast 1 with 5-7 turns; end wall plane, width 26-30 µm, 150-300 µm long. *S. longata* (Vaucher) Kuetzing 1843., Vegetative cells 19-27µm x 99-165µm; septa plane; chloroplasts 1, making 6-8 turns. Conjugation scalariform and lateral; tubes formed by both gametangia; female gametangia enlarged up to 37µm in diameter; zygospore globose, 23-30µm x 44-56µm and ovoid, mesospore brown and smooth. *S. semiornata* Jao, 1935., Filaments of vegetative cells cylindrical, 204.82-235.9 µm long, 29.26-31.18 µm broad; septa replicate; chloroplast 1 with 3-6 turns; pyrenoids 6-8; conjugation scalariform; tubes formed by both gametangia; fertile cells cylindrical, 209.56-239.55µm long, 30.38-37.78 µm broad; zygospores ovoid, 60.34-62.17 µm long, 34.25-36.79 µm broad; mesospore wall smooth yellowish brown. *Spirogyra chenii* Jao, 1935., Spore membrane yellow, smooth; plane transverse wall and single chloroplast with 3-5 turns; gametangia shape inflated on both sides; ladder-like and lateral conjugation; ellipsoid zygospore 24-27 x 42-52 µm, end wall plane; cells 17-22 µm in diameter, 110-300 µm long. *S. minuticrassoidea* Link, 1820., Spore membrane yellow-brown, smooth; gametangia cylindrical in shape; ladder-like conjugation; lenticular zygospore (compressed ellipsoid), 100-107 x 125-144 x 68-90 µm; plane transverse wall and multiple chloroplast with 2.5-3 turns; end wall plane, width 95-112 µm, 295-515 µm long. *S. pseudomaxima* (Hassal) Wittrock 1882., (Plate:4) Spore membrane brown, reticulate; lenticular zygospore 112-124 x 112-124 x 90-95 µm; gametangia cylindrical, ladder-like conjugation; end wall plane; plane transverse wall and multiple chloroplast with 1-1.5 turns; width 135-140 µm and 190-430 µm long. *S. chungkingensis* Jao, 1935., Spore membrane two layered, outer brownish, wrinkled; inner brown, irregularly reticulate; inflated gametangia.; ovoid zygospore 33-35 x 55-83 µm; plane transverse wall and multiple chloroplast with 4-5 turns; ladder-like conjugation; end wall plane, width 24-27 µm in diameter and 150-300 µm long.

36. *Mougeotia* sp.

Mougeotia sp. C.A. Agardh 1872., Filaments unbranched; cells cylindrical, longer than broad; cell wall thin; septa plane; chloroplast flat axial plate; nucleus one; pyrenoids several, linear; reproduction by fragmentation or aplanospore, sexuality scalariform or lateral conjugation; zygospores globose, spheroid or quadrate- ovoid. *M. elegantula* Wittrock 1872., (Plate:4) Filaments very slender, becoming geniculate in conjugation; cells long-cylindrical, 4-4.5µm in diameter, 50-135 µm long; chloroplast a thin plate, not quite equalling the cell in length, containing 4-8 pyrenoids. Zygospores formed in the tube and dividing both gametangia; quadrate with concave margins, the wall smooth, hyaline; 18-25 µm in diameter. *M. varians* (Wittrock) Czurda 1932., Vegetative cells 25-27 µm in diameter; chloroplast a broad band entirely filling the length of the cell, with 4 pyrenoids. Zygospores

formed in the tube, dividing one of the gametangia; cylindrical or drum-shaped, the free walls concave, the walls adjoining the gametangia convex; median wall smooth and brown; 48-60 μm in diameter, 60-70-(78) μm long. *M. tumidula* Transeau 1914., Vegetative cells long-cylindrical, 6-8 μm in diameter, up to 120 μm long; chloroplast a broad plate with 4-8 pyrenoids in one series. Zygospores formed in the tube, dividing both gametangia; quadrangular; both inner and outer spore walls minutely scrobiculate; 22-26 μm in diameter, 26-30 μm long.

37. *Cosmarium* sp.

C. depressum (Nageli) P.Lundell, 1871., (Plate:4) Cells slightly broader than long. Sinus deep, closed to about half-way, then much dilated. Semicells entire, in outline transversally ellipsoid with slightly convex to somewhat truncate apex, in apical view ellipsoid as well. Cell wall smooth. Cell length 30-45 μm , breadth 32-50 μm . *C. reniforme* (Ralfs) W.Archer, 1874., (Plate:4) Cells longer than broad. Sinus deep, open at the apex and the exterior, closed half-way. Semicells reniform. Cell wall beset with coarse granules arranged in regular, longitudinal rows. Apical view ellipsoid. Zygospores globose to broadly elliptic, smooth walled. Cell length 46-64 μm , breadth 44-56 μm . *C. angulosum* Brebisson 1856., (Plate:4) Cell small, semi cells slightly broad towards the faintly convex apex, upper angles produced into more or less horizontally disposed long processes, tipped with 3 minute spines and sharing many concentric series of denticulations, cells 24-27 μm long, 37-39 μm broad with processes, isthmus 4-5 μm broad. *C. angulosum* Var. *Concinnum* (Rabenhorst) West & West, 1901., (Plate:4) Cells very small, a little longer than broad, deeply constricted, sinus narrow and linear, semi-cells hexagonal with sharp angles and parallel sides, apex narrow and slightly retuse; cell wall smooth. Cells 9.5-15.42 μm diameter, Cells 11.5-16.81 μm long, isthmus 5.6-5.7 μm . *C. divergens* Krieger, 1932., (Plate:5) Cell deeply constricted; cell wall crenate; semi-cells somewhat rectangular with flat apices. Cells 16.8-20.6 μm broad, 21-24.3 μm long and isthmus 4.1-8.2 μm broad. *C. pseudoretusum* Ducelier, 1918., (Plate:5) Cells longer than broad, deep median constriction, linear sinus, closed, dilated in the apex; 3-lobed semiclubs, rounded basal lobes, lobes upper truncates, sub-rectangular basal angles, rounded, bent upper lateral margins, superior angles oblique, slightly rounded, truncated upper margin straight; smooth cell wall; chloroplast not observed; View vertical elliptical; swollen lateral margins; side view widely elliptical. Cells 21.7 μm broad, 30 μm long and isthmus 5.2 μm broad. *C. moniliforme* (Turpin) Ralfs, 1848., (Plate:5) Cells 23.25-35.68 μm long, 13.27-20.56 μm broad; margin entire; semicell circular or subcircular; isthmus 7.36- 9.47 μm broad; constriction deep; sinus open; wall smooth; chloroplasts axile, in each semicell; pyrenoids 2. *C. formosulum* Hoff, 1888., (Plate:5) Cell longer than broad, deeply constricted, sinus linear, semi cells broadly ovate, less unequal; margin slightly crenate, apices of semi cells slightly compressed. Cell wall smooth chloroplast axile with two pyrenoids. Cells 31.8-37 μm broad, 45-50.8 μm long, isthmus 10.8-11.6 μm wide.

38. *Pleurotaenium* sp.

P. maculatum (Turner) Carter, 1926., (Plate:5) Cells large and robust, very long, about 16 times longer than broad, semicells of even diameter, with one distinct basal swelling above the isthmus and terminating in an expanded apex ornamented by ring of 13-16 prominent conical tubercles; cells 686-756 μm long, 40-55 μm broad; isthmus 45 μm wide. *P. ovatum* Nordst, 1877., (Plate:5) Cell body 230 μm long, 90 μm wide, L/W= 2.6, isthmus 53 μm wide. *P. trabecula* (Ehrenberg) Nageli, 1849., Cell cylindrical, 260-660 μm long, 24-45 μm diameter. L/W= 11-18, constricted at center, semicells bulged at base; chloroplast elongate, with 3-4 laminae; cell wall dotted.

39. *Closterium* sp.

C. leibleinii Kuetzing ex Ralfs 1848., (Plate:5) Cells rather slightly arched, length 7-8 times than broad, usually inflated in the ventral side of the mid region, equally attenuated towards the apices. Apices narrowly rounded, 3-4 μm in breadth, with a small, indistinct end pores. Cell wall without girdle bands, colorless, smooth. Cell length 190-200 μm , breadth 26-27 μm . *Closterium venus* Kuetzing ex Ralfs, 1848., Cell body small, strongly curved, inner side not convex, both ends pointed, 48-85 μm long, 6-11 μm wide. Cell wall smooth, transparent or brownish in color; 1-2 pyrenoids in each chloroplast, one lamina visible. *C. littorale* F.Gay 1884., (Plate:5) Cells slightly arched, about 10-11 times longer than broad, usually inflated in the ventral side of the mid-region, gradually attenuated towards the ends. Apices slightly obliquely, truncately rounded. Cell wall without girdle bands, colorless to brownish, seemingly smooth. Cells with 5-7 pyrenoids per semicell, arranged in an axial row. Cell length 275-295 μm , breadth 26-27 μm . *C. praelongum* Var. *brevius* (Nordst) W. Krieger 1935., Cells significantly shorter and commonly marginally narrower than the nominate variety, 16-22 times longer than broad, gradually tapered toward from the middle part, scarcely recurved in the apical region. The cell wall striae are more delicate and therefore more difficult to observe than the nominate variety. Cell length 200-330 μm , breadth 12-15 μm . *C. pitchardianum* W. Archer 1862., Cells very curved to almost straight, 21-22 times longer than broad, more or less parallel margins in the mid-region, attenuated towards the apices. Cell ends just below the apex attenuated more strongly and slightly recurved. Apices truncately rounded. Cell wall without true girdle bands, colorless to brownish. Cell wall sculpture consisting of delicate punctae or short striae arranged in longitudinal rows, passing into an irregular pattern of punctae near the apex. Cell length 800-820 μm , breadth 35-40 μm . *C. lunula* Ehrenberg & Hemprich ex Ralfs, 1848., (Plate:5) Cell body large, L/W= 5-8; inner-side nearly straight, outer-side curved; tapered at both termini (broad circle, slightly inversed); cell wall smooth, transparent, without bands; chloroplasts with many pyrenoids.

40. *Euastrum* sp

E. ceylanicum (West & West) Krieger, 1937., (Plate:5) Cells solitary, green, slightly longer than broad; constricted sinus, open, widely, linear; semicells three lobed; lateral wall with short spine; cells 40 μm long and 35 μm broad; isthmus 8 μm broad. *E. ansatum* Ehrenberg ex Ralfs, 1848., (Plate:5) Cells solitary green, cells longer than broad, sinus deeply constricted at middle, narrowly linear; apical margin of semicells elevated, polar lobe elevated with an enlarged deep median incision, cells 80-85 μm long and 38 μm broad; isthmus 15 μm broad.

41. *Desmidium* sp

D. elegans C. A. Agardh ex Ralfs, 1848., (Plate:5) Cells longer or shorter than broad, with distinct or indistinct median constriction where semicell walls overlap. Cells united into long filaments, either by entire apical surface of adjacent cells or by apical processes. Cells 3-5 angled or elliptical in apical view. Cell angles usually slightly offset on each semicell, producing helical pattern of angles along filament. Cell wall smooth with pores in transverse rows of scattered. One chloroplast per semicell, stellate in end view, with central pyrenoid, or with pyrenoid in each lobe. Nucleus at isthmus between chloroplasts. Asexual reproduction by

cell division with formation of replicate division septum. Sexual reproduction by conjugation. Gametes fuse between gametangia. Mature zygospores spherical to ellipsoid, smooth walled or with rounded warts. *D. baileyi* (Ralfs) Nordst, 1880., (Plate:5) Vertical view quadrangular. Differs in the much longer apical process, which show a slight indentation at the point of out growth. Cells 16µm long, 21µm wide.

42. *Penium spinospermum* Joshua, 1883

Cells solitary, small, very slightly attenuated towards apex; apex rounded; unconstructed at the middle; chloroplast one axial with three ridges and one pyrenoid; cells 2.5 times longer than broad, 25-30 µm long and 10-15 µm broad (Plate:5) .

43. *Actinotaenium diplosporum* (P. Lundell) Teiling, 1954

Cells more or less cylindrical, with parallel or toward the apices slightly diverging lateral sides. Sinus very shallow and widely open. Apices broadly rounded, often with thickened cell wall. Chloroplast asteroid. Cell length 50-85 µm, breadth 21-40 µm, L/Br 1.8-2.4. Twin zygospores in formal view irregularly quadrate to almost globular with adhering empty gametangial semicells (Plate:5) .

44. *Xanthidium sexmammillatum* West & West, 1907

Cell body 50-102 µm long, 45-102 µm wide, isthmus 12-13 µm (Plate:5) .

45. *Zygnema* sp (Plate:5)

Z. terrestre Randhava 1938., (Plate:5) *Zygnema* is a brittle worst (or) stone worst. Un-branched filaments of short cylindrical cells, often covered by a peptic sheath, vegetative cells 1-9 times longer than broad, usually with 2 distinctly stellate chloroplast (rarely 1-4) each with prominent central paranoid chloroplast connected by a cytoplasmic isthmus containing the nucleus. *Zygnema cylindricum* C.A. Agardh 1824., (Plate:5) Unbranched filaments of short or long cylindrical cells with plane end walls, inclosed by a soft mucilaginous sheath, rarely with irregular rhizoidal outgrowths of a few cells when in contact with the substrate, chloroplasts 2 (rarely 4) axial, stellate masses, each containing a large central pyrenoid with a conspicuous starch sheath. Conjugation mostly scalariform, with the zygospores formed in the connecting tube, or rarely in one of the gametangia, but not cut off by membranes from the gametangial cells. Zygospores spherical, ovate or ellipsoid, with a thick, 3-layered wall, the outer and middle layers variously sculptured with scrobiculations and punctations. Asexual reproduction by aplanospores and akinetes. *Z. oveidanum* C.A. Agardh 1824., (Plate:5) Unbranched filaments of short or long cylindrical cells with plane end walls, inclosed by a soft mucilaginous sheath, rarely with irregular rhizoidal outgrowths of a few cells when in contact with the substrate, chloroplasts 2 (rarely 4) axial, stellate masses, each containing a large central pyrenoid with a conspicuous starch sheath. Conjugation mostly scalariform, with the zygospores formed in the connecting tube, or rarely in one of the gametangia, but not cut off by membranes from the gametangial cells. Zygospores spherical, ovate or ellipsoid, with a thick, 3-layered wall, the outer and middle layers variously sculptured with scrobiculations and punctations. Asexual reproduction by aplanospores and akinetes. *Z. cruciatum* (Vaucher) Agardh 1824., (Plate:5) Plants are unbranched filaments of short cylindrical cells with plane end wall. The cells have two stellate chloroplasts and each chloroplast with a conspicuous central pyrenoid. Vegetative cells are 32-39µm in width and 35-50 µm in length. Sexual reproduction is scalariform conjugation. Zygospores are formed in only female gametangia that remain cylindrical or slightly enlarged on the conjugating side. Zygospores are yellow-brown, mostly spherical or broad, ovoid, 35-44 µm wide, and 40-47 µm long.

46. *Cylindrocystis* sp. De Bary 1858

Cell body cylindrical or spindle- shaped, loosely attached with each other to form a filamentous colony; cell wall smooth, consists of a single partition, one layer; 1-2 chloroplasts plate- or ribbon- like, with pyrenoids; (Plate:5) a single nucleus centrally placed. Two chloroplasts with axis and laminae structure; axis short, laminae also short making the chloroplasts star shaped at end of the cell.

47. *Micrasterias brachyptera* P.Lundell 1871

Cells in rough outline ellipsoid. Sinus from the apex usually initially closed or narrowly open, then widened. Apical lobes remarkably clumsy with a slightly swollen neck and an abruptly widened top distinctly standing out above the upper lateral lobes (Plate:5) . Apices with a wide, median incision/ indentation. Lateral lobes of the first order divided into second and third order lobes. Upper lateral lobes separated from the apical lobes by rather deep, rather wide incisions. Cell wall with avariable number of short spines scattered over the surface. Cell length 200-230 µm, breadth 140-180 µm, L/Br 1.2-1.45.

48. *Hyalotheca mucosa* Ralfs 1848

Cell body 12.8-13.6 µm long, 11.2- 12.8 µm broad; special rounded structures in two rows at the isthmus region. It is characterized by cylindrical cells that do not have a distinct sinus constriction. The cells are about equal in the width and length, or slightly longer than wide (Plate:5) .

49. *Staurastrum* sp.

S. pinnatum Krieger 1932., (Plate:5) Cell is small in size. Length is similar to its width. The median constriction narrowly constricted, sinus is open with a V-shaped notch, isthmus broad. Semi cell is oval to broadly bowl-shaped, the apical process short, the base of the semi cells with a transverse series of sharp granules. The processes have 3 teeth. In vertical view cell is circular with 5 processes. Length of cell is 25-26 µm, width is 25-30 µm, and isthmus is 10 µm. *S. bieneanum* Robenhorst 1912., (Plate:6) Cells slightly broader than long, very deeply constricted, sinus widely open, semi cells narrowly elliptic, 22-33.3µm long, 24-27.8µm broad, isthmus is 9.5-12.2µm broad. *S. convolutum* Meyen ex Ralfs, 1848., (Plate:6) Cells small to large, 2-12 radiate in end view, with shallow or deep median constriction (isthmus) where semicell walls overlap, and two intergrading cell morphologies; processes usually with two or more terminal spinules, and possibly one or more series of denticulations, spines or verrucae along process and on apex and body of central axis of semicell; cell wall smooth or with rows of small granules or spinules. Chloroplasts usually one per semicell, stellate in end view, with axial pyrenoid or with several pyrenoids in lobes extending into cell angles or processes. Nucleus is isthmus. Asexual reproduction by cell division and new semicell formation; sexual reproduction by conjugation; gametangia come together within broad gelatinous envelope; gametangia fuse in conjugation tube. Mature zygospores usually

spherical, with long furcate spines. *S. recurvatum* W.B. Turner 1893., (Plate:6) Cells radially symmetrical, 20.57-22.43 μm long, 29.32-31.52 μm broad; isthmus deep, 5.47-6.15 μm broad; sinus open; semicells fusiform with dorsal margin undulate and ventral tumid; apices recurved with 3-4 spines; chloroplasts axile; pyrenoid 1. *S. saltans* W. Joshua 1882., (Plate:6) Cell body 30 μm long, 48-70 μm wide, isthmus 10-11 μm . *S. gracile* Ralfs ex Ralfs 1848., (Plate:6) Vertical view of the cell is triangular, with sides straight or slightly concave and the angles produced to form long processes, elongated ridges seen inside the lateral sides running parallel to it, cells 29-32.6 μm broad. *S. paradoxum* Meyen ex Ralfs 1848., Cells broader than long to about as broad as long, deeply constricted. Sinus widely open and acute-angled. Semicells campanulate or cup-shaped, the apical angles attenuated to form rather long, stout, diverging processes. Processes tipped with 3-5 stout spines and towards the semicell body furnished with acute granules or denticulations being arranged in concentric series. Semicell body also furnished with granules/ denticulations but almost exclusively on the apex. Semicells in apical view 3-4 radiate with about straight sides, the angles attenuated into processes. Zygosporangium more or less globose, furnished with long spines that are variably furcate. Cell length 30-47 μm , breadth 32-60 μm . *S. tetracerum* Ralfs ex Ralfs 1848., Cells 7-10 μm long, 18-30 μm broad, isthmus 4-6 μm width. *S. sonthalianum* Turner 1893., (Plate:6) Cells 39-48 μm long, 53-77 μm broad, isthmus 12-13.5 μm wide.

50. *Gonatozygon monotaenium* De Bary 1856

Cell body cylindrical (74-145)- 284 μm long, 7.5-11.5 μm wide, L/W= 10-25, cell wall granulated, both ends slightly swelled, 2 chloroplasts with 4-10 pyrenoids in each (Plate:6).

51. *Coleochaete pulvinata* A. Braun 1849

The plant body may be homothallic i.e., monoecious. In well-developed heterotrichous form like, the antheridia are borne in groups at the apex of erect branches. *Coleochaete pulvinata* the first division is vertical and both the cells undergo repeated division to form a prostrate system (Plate:6).

52. *Glaucozystis major* Itzigsohn 1866

Characters same as in *Oocystis* with the difference that chromatophores are lacking. The vermiform blue green stellately arranged chloroplast-like bodies inside really belong to a rod-shaped member of the Chroococcales and the relationship between the colorless *Oocystis*-like alga and the blue green has been considered as one of the symbiosis. Reproduction by autospores (Plate:6).

53. *Nitella* sp. C. A. Agardh 1824

Filamentous green alga with very large and long cells forming primary axis and whorls of branches (Plate:6). These secondary branches are themselves branched. Mature plants 30-100 cm high, attached with numerous basal rhizoids, these multicellular colorless and branched. Primary axes with alternating sequence of nodal and intermodal cells developed from apical cell. Each apical cell derivative divides transversely and the daughter cells develop into multicellular nodal complex with 6 peripheral cells, and its intermodal cell, respectively.

54. *Asterococcus* sp. Scherffel, 1908

Cells globose or subglobose, either solitary or in colonies of from 4-16, in colorless homogeneous envelopes of mucilage. Chloroplast a stellate mass with radiate arms from a central core, which contains a pyrenoid (Plate:6).

55. *Elakatothrix gelatinosa* Wille 1898

Colonies free-floating, elongate fusiform to irregular with the long axes of cells parallel to the long axis of the colony. Colonies usually with 1-16-32, rarely up to 50 cells. Cells usually in pairs, spindle-shaped with one pole rounded and the other pointed, the rounded end of a pair of cells being in opposition. Cells in single-celled colonies with both ends uniformly attenuated. Chromatophore single, parietal, covering the entire length of the wall and with a pyrenoid. Cells 2.5-6 μm broad, 11-30 μm long. Colonies 10-30 μm broad and 70-160 μm long (Plate:6).

56. *Dictyosphaerium* sp

D. simplex Korshikov 1953., (Plate:6) Colonies free floating, consisted of 4-64 cells, only rarely with more cells, with distinct and regular stalk branching, 4-celled colonies 25-40 μm in diameter, 64-celled to 50 μm in diameter. Mucilaginous envelopes hyaline, not stratified, 5-8 μm wide around cells. Cell shape varies depending upon their age. Maturing cells spherically oval or oval to ovoidal attached to stalks. Chloroplast cup-shaped with a oval pyrenoid. Cells 8 μm in diameter, 13 μm long. *D. chlorellioides* (Neuman) Komarek & Perman, 1978., Generally it was similar. The chloroplast was always located at one side of the cell covering half or 2/3 of cells inner surface and had a smooth or wavy edges. The pyrenoid was surrounded by several (5-6) starch grains. The pyrenoid matrix was traversed by two or three thylakoid membranes. The nucleus was located

57. *Trebouxia* sp. Puymaly 1924

Trebouxia being one of the most common genera of coccoid algae found in lichen thallus (Plate:6). It is a unicellular green alga. It is a primary producer of marine, fresh water and terrestrial ecosystems. It uses carotenoids and chlorophyll a and b to harvest energy from the sun and provide nutrients to various animals and insects

57. *Chlorella* sp.

C. vulgaris Beijerinck 1890., Cell solitary, unicellular, green spherical, cell wall thin, chloroplast cup shaped with a distinct pyrenoid at centre; cell 6.4 μm in diameter; cell reproduction is by formation of 2 or 4 autospores of the same size, set free by the rupture of mother cell wall; young cells either ellipsoidal or spherical. *C. peruviana* Beijerinck 1890., (Plate:6) Unicellular, solitary or aggregated in irregular clumps; round or ellipsoid; variable in size in the same habitat. Chloroplast a parietal cup or merely a plate, with or without a pyrenoid. Reproduction by 4 or 8 daughter cells (non-motile) produced from the protoplast of the mother cell. *C. ovalis* Butcher 1952., (Plate:6) This species was found in a brackish habitat. The cells have an oval to ellipsoidal cell shape, and are 3.0 x 5.0- 5.0 x 10.0 μm in size. The chloroplasts are parietal, band-like and slightly lobed, without a pyrenoid. Reproduction occurs through forming eight autospores. *C. luteoviridis* Chodat 1913., (Plate:6) Cells always spherical, 4-10 μm in diameter. Chromatophore disc-shaped; green to yellow-green, pyrenoid present.

59. *Botryococcus braunii* Kutzing 1849

Colonies microscopic, free floating, irregular grape-like shape, formed by several globes or ovoid, botryoidal, small cell clusters, connected with long or short rubbery gelatinous strands (Plate:6). Cells elongated, ovoid or ellipsoid, conically narrowed towards the colony center matrix extremely elastic, each enclosed in tough, hyaline gelatinous sheath and radiately arranged at the

periphery in each botryoidal cell cluster, often impregnated with colorless or orange oil, in latter case colony brown to brick-red. Cells 3-6µm in diameter, 6-15µm long.

60. *Micractinium* sp. Fresenius 1858

The cells live solitary or in colonies and spherical to broadly ellipsoidal, and are usually quadrately united in four-celled coenobia (Plate:6) . The coenobia in turn, are almost always united with other coenobia to form a multiple coenobium has two to seven fine and long setae with a length several times the diameter of the cell. Each cell contains a single cup-shaped chloroplast with one pyrenoid.

61. *Amphikrikos minutissimus* Korshikov 1953

Cells solitary or arranged in 4-8 celled autosporangia, with indistinct hyaline mucilaginous envelopes, 10-15-(35) x 6-12-(23) µm (Plate:6) . Cells short cylindrical to cylindrical-oval, 5-7 x 2-3.5 µm, conically to shortly attenuated ends and with a ring of irregular brown granules at both poles. Chloroplast parietal, with a pyrenoid. Autospores 4-8, from the onset arranged closely together in expanded mother cell walls.

4. RESULTS AND DISCUSSION

In the present study, 164 taxa have been collected from waterfalls in (Table 1). Identification of algal taxa was done using diagnostic dichotomous keys, based mainly on simple morphological characters in the description of chlorophyceae. Fig. 1 describes the diversity of 17 orders, 61genus, 32 families, and 164species. Fig. 2 illustrates the species richness in the sampling area. Of these, dominant numbers were found in *Oedogonium* sp., *Spirogyra* sp., *Scenedesmus* sp., *Staurastrum* sp., *Cosmarium* sp., and *Pediastrum* sp. Industrially important species like *Chlorella* sp., *Botryococcus* sp., *Spirogyra* sp., *Haematococcus* sp., and *Chlamydomonas* sp., were also identified during the study period. The number of species distribution in five different sampling stations was also counted and expressed in graphically.,(Fig. 3), where the order of distribution found to be as follows: S2 (26), ≤ S1 (37), ≤ S3(58), ≤ S4 (53), ≤ S5 (70). Imagery morphology were documented from Plates 1 to 6, which included 164 microalgae of Chlorophyceae. Totally 164 species were identified under 17 orders and 32 families (Fig. 1), which were classified by F.E.Fritsch (1984 &1985). The number of species in five different sampling stations was recorded; of these, S5 (New fall or Main fall) showed the maximum number and was best suitable for microalgal growth, because of water flow throughout the year (Fig:3).

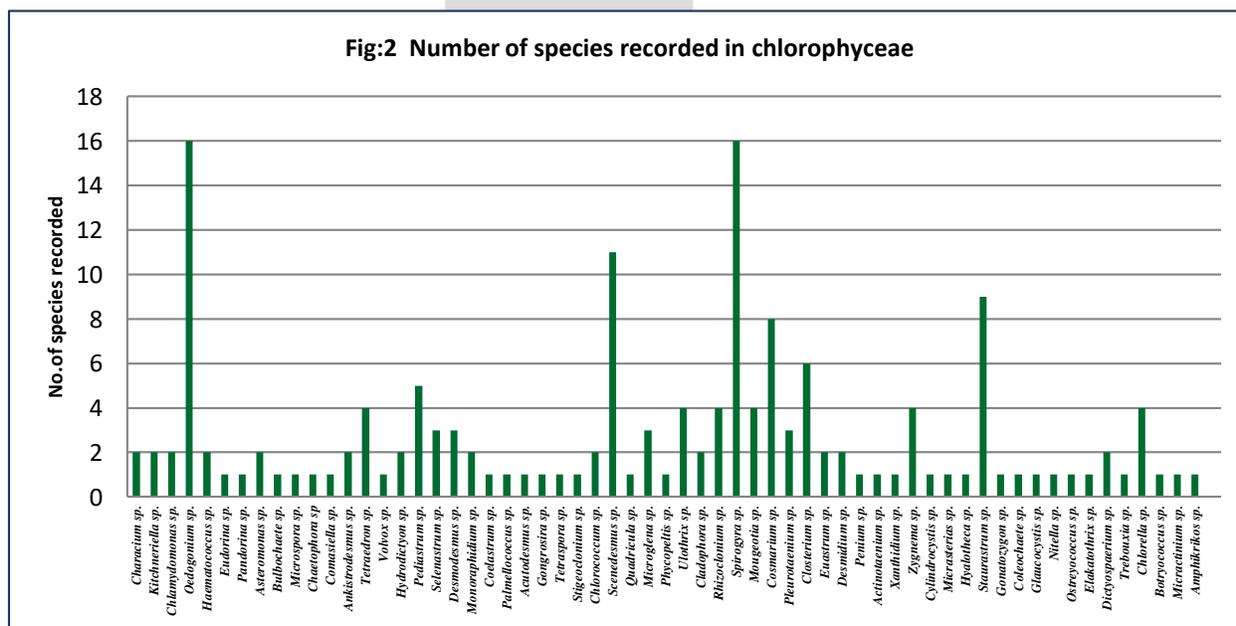
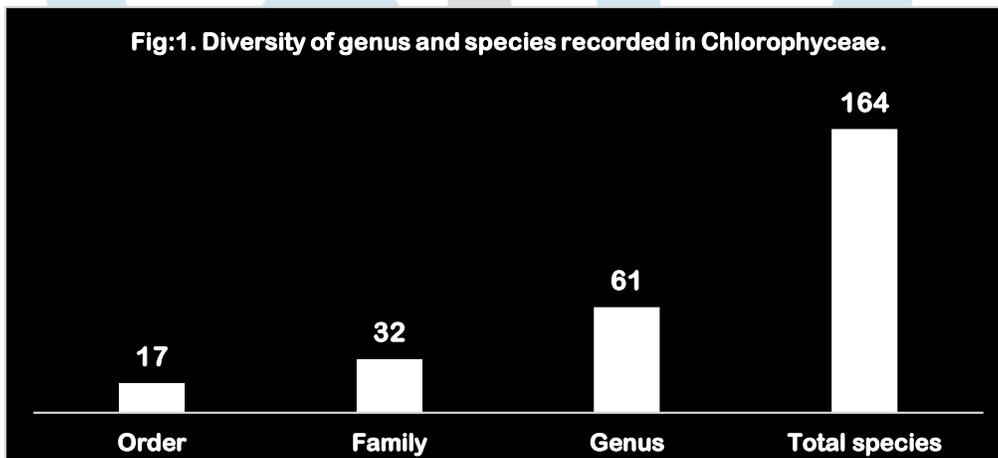
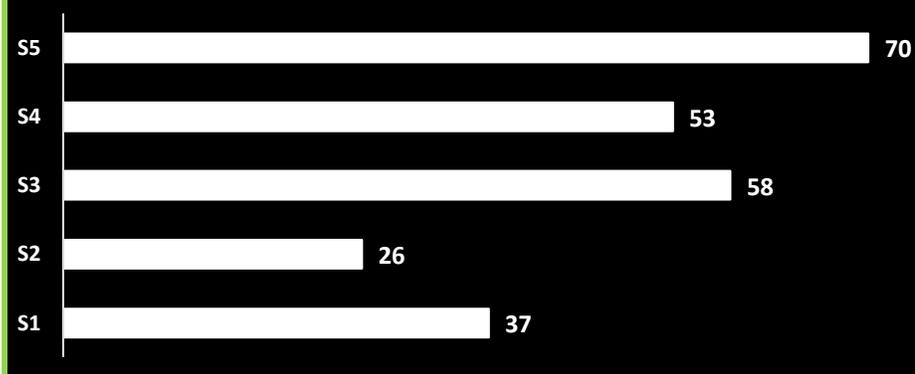


Fig:3. Number of Chlorophycean species recorded in five different water falls of Courtallam.**Table: 1. List of microalgae collected from different sampling area**

SL.NO	Binomial	S1	S2	S3	S4	S5
I.CHLOROPHYCEAE						
1	<i>Characium ambiguum</i>	-	-	+	-	-
2	<i>Characium rabenhorstii</i>	-	-	-	+	+
3	<i>Kitchneriella elongata</i>	-	-	+	-	-
4	<i>Kitchneriella contorta</i>	-	-	-	-	+
5	<i>Chlamydomonas sp.</i>	+	+	-	-	-
6	<i>Chlamydomonas reinhardi</i>	+	-	+	-	+
7	<i>Oedogonium young thallus</i>	-	+	-	-	+
8	<i>Oedogonium young thallus</i>	+	-	-	-	-
9	<i>Oedogonium sp. with sex organ</i>	-	-	-	-	+
10	<i>Oedogonium macrandrous</i>	-	-	-	-	+
11	<i>Oedogonium nanandrous</i>	-	-	-	-	+
12	<i>Oedogonium pectorum</i>	-	-	-	+	-
13	<i>Oedogonium gracilius</i>	+	-	+	-	+
14	<i>Oedogonium hispidum</i>	-	+	-	+	-
15	<i>Oedogonium giganteum</i>	-	-	+	-	+
16	<i>Oedogonium globosum</i>	-	-	-	+	-
17	<i>Oedogonium anomalum</i>	-	-	-	-	+
18	<i>Oedogonium nodulosum</i>	-	-	-	+	+
19	<i>Oedogonium hindustanense</i>	-	-	+	-	+
20	<i>Oedogonium mexicanum</i>	-	-	+	-	-
21	<i>Oedogonium pringsheimii</i>	-	-	+	-	-
22	<i>Oedogonium crispum</i>	-	-	-	+	+
23	<i>Haematococcus sp.</i>	-	-	+	+	-
24	<i>Haematococcus pluviialis</i>	-	-	-	-	+
25	<i>Eudorina sp.</i>	-	+	+	-	-
26	<i>Pandorina sp.</i>	-	-	-	+	+
27	<i>Asteromonas sp.</i>	-	-	-	-	+
28	<i>Asteromonas gracilis</i>	+	-	-	-	-
29	<i>Bulbochaete sp.</i>	-	-	-	+	+
30	<i>Microspora willeana</i>	-	-	-	-	+
31	<i>Chaetophora attenuate</i>	-	+	-	-	-
32	<i>Comasiella arcuata var. platydisca</i>	-	-	-	-	+
33	<i>Ankistrodesmus arcuatus</i>	-	-	-	-	+
34	<i>Ankistrodesmus fusiformis</i>	-	-	+	-	-
35	<i>Tetraedron trigonum</i>	-	-	-	-	+
36	<i>Tetraedron regulare</i>	-	-	-	+	-
37	<i>Tetraedron triangulare</i>	-	-	+	-	-
38	<i>Tetraedron muticum</i>	-	+	-	-	+
39	<i>Volvox sp.</i>	+	-	+	+	-
40	<i>Hydrodictyon sp.</i>	-	-	-	-	+
41	<i>Hydrodictyon reticulatum</i>	-	-	+	-	-
42	<i>Pediastrum duplex</i>	-	-	-	+	-
43	<i>Pediastrum duplex var. clathratum</i>	-	-	-	-	+
44	<i>Pediastrum simplex</i>	-	+	-	-	+
45	<i>Pediastrum boryanum</i>	-	-	+	+	-
46	<i>Pediastrum ovatum</i>	-	-	-	-	+
47	<i>Selenastrum sp.</i>	-	-	+	-	-
48	<i>Selenastrum gracile</i>	-	+	-	+	-
49	<i>Selenastrum bibrainum</i>	-	-	+	+	-
50	<i>Desmodesmus abundans</i>	-	-	-	-	+
51	<i>Desmodesmus dispar</i>	-	-	+	-	-

52	<i>Desmodesmus multivariabilis</i>	-	-	-	-	+
53	<i>Monoraphidium sp.</i>	+	-	-	-	+
54	<i>Monoraphidium circinale</i>	-	-	-	-	+
55	<i>Coelastrum intermedium</i>	-	-	-	+	-
56	<i>Palmellococcus saccharophilus</i>	-	+	-	-	+
57	<i>Acutodesmus obliquus</i>	-	-	-	-	-
58	<i>Gongrosira fluminensis</i>	-	-	+	-	+
59	<i>Tetraspora gelatinosa</i>	-	-	-	+	-
60	<i>Stigeoclonium tenue</i>	-	-	+	-	-
61	<i>Chlorococcum infusionum</i>	-	+	-	-	-
62	<i>Chlorococcum humicola</i>	+	-	-	-	+
63	<i>Scenedesmus incrassatulus</i>	+	-	+	-	-
64	<i>Scenedesmus quadricauda</i>	+	-	+	-	+
65	<i>Scenedesmus bijugatus var. graevenitzii</i>	-	+	-	-	-
66	<i>Scenedesmus dimorphous</i>	-	-	+	+	-
67	<i>Scenedesmus arcuatus var. capitatus</i>	-	-	-	-	+
68	<i>Scenedesmus ginzbergeri</i>	-	-	-	+	-
69	<i>Scenedesmus graevenitzii</i>	-	-	-	-	-
70	<i>Scenedesmus quadricauda var. longispina</i>	-	-	+	-	-
71	<i>Scenedesmus quadricauda var. quadrispina</i>	-	-	-	+	-
72	<i>Scenedesmus quadricauda var. westii</i>	-	-	+	-	-
73	<i>Scenedesmus denticulatus</i>	-	-	-	-	+
74	<i>Quadrigula lacustris</i>	-	+	-	-	+
75	<i>Microglena coccifera</i>	-	-	+	+	-
76	<i>Microglena basinucleata</i>	-	-	-	-	+
77	<i>Microglena charkoviensis</i>	-	+	-	-	-
78	<i>Phycopeltis sp.</i>	-	-	+	-	+
79	<i>Ulothrix cylindricum</i>	+	-	-	-	-
80	<i>Ulothrix subconstricta</i>	-	-	-	+	-
81	<i>Ulothrix variabilis</i>	-	-	+	-	-
82	<i>Ulothrix zonata</i>	+	-	-	+	-
83	<i>Cladophora glomerata</i>	+	-	-	-	+
84	<i>Cladophora oligoclona</i>	-	+	-	-	-
85	<i>Rhizoclonium hieroglyphicum</i>	-	-	+	+	-
86	<i>Rhizoclonium tortuosum</i>	-	-	-	-	+
87	<i>Rhizoclonium ramosum</i>	-	-	+	-	-
88	<i>Rhizoclonium riparium</i>	-	-	-	+	+
89	<i>Spirogyra elliptica</i>	+	-	-	-	-
90	<i>Spirogyra gracilis</i>	+	-	-	-	+
91	<i>Spirogyra decimina</i>	+	-	+	-	-
92	<i>Spirogyra iyengari</i>	-	+	-	-	+
93	<i>Spirogyra fluviatilis</i>	-	-	-	+	-
94	<i>Spirogyra varians</i>	-	-	+	-	-
95	<i>Spirogyra platensis</i>	+	-	-	+	-
96	<i>Spirogyra dentireticulata</i>	-	-	-	+	-
97	<i>Spirogyra mirabilis</i>	-	-	+	-	+
98	<i>Spirogyra punctate</i>	-	+	-	-	+
99	<i>Spirogyra longata</i>	-	-	+	-	+
100	<i>Spirogyra semiornata</i>	-	-	+	-	-
101	<i>Spirogyra chenii</i>	-	-	-	+	-
102	<i>Spirogyra minuticrassoidea</i>	-	-	+	-	-
103	<i>Spirogyra maxima</i>	-	-	-	-	+
104	<i>Spirogyra chungkingensis</i>	-	+	-	+	+
105	<i>Mougeotia sp.</i>	+	-	-	-	-
106	<i>Mougeotia elegantula</i>	-	+	-	+	-
107	<i>Mougeotia varians</i>	-	-	-	+	-
108	<i>Mougeotia tumidula</i>	-	-	+	-	+
109	<i>Cosmarium depressum</i>	-	+	-	+	-
110	<i>Cosmarium reniforme</i>	+	-	-	-	+
111	<i>Cosmarium angulosum</i>	+	-	+	+	-
112	<i>Cosmarium angulosum Var. concinnum</i>	-	-	-	-	+
113	<i>Cosmarium divergens</i>	-	+	+	-	-
114	<i>Cosmarium pseudoretusum</i>	-	-	-	-	+
115	<i>Cosmarium moniliforme</i>	-	-	+	+	-
116	<i>Cosmarium formosulum</i>	+	-	-	-	+
117	<i>Pleurotaenium maculatum</i>	-	+	+	-	-
118	<i>Pleurotaenium ovatum</i>	-	-	-	-	+
119	<i>Pleurotaenium trabecular</i>	-	-	-	+	-
120	<i>Closterium leibleinii</i>	+	-	-	-	-
121	<i>Closterium venus</i>	-	-	+	+	-
122	<i>Closterium littorale</i>	-	+	-	-	-
123	<i>Closterium cf. pralongum Var. brevius</i>	-	-	+	-	-
124	<i>Closterium pritchardianum</i>	-	-	-	+	+
125	<i>Closterium lunula</i>	+	-	+	-	-
126	<i>Euastrum ceylanicum</i>	+	-	-	-	+
127	<i>Euastrum ansatum</i>	+	-	-	-	-
128	<i>Desmidium elegans</i>	+	-	+	-	-

129	<i>Desmidium baileyi</i>	-	-	-	+	-
130	<i>Penium spinospermum</i>	-	-	-	-	+
131	<i>Actinotaenium diplosporum</i>	-	-	+	+	-
132	<i>Xanthidium sexmammillatum</i>	-	-	-	-	+
133	<i>Zygnema terrestre</i>	+	+	-	-	-
134	<i>Zygnema cylindricum</i>	+	-	-	+	-
135	<i>Zygnema ovoidanum</i>	+	-	-	+	-
136	<i>Zygnema cruciatum</i>	-	-	+	-	-
137	<i>Cylindrocystis sp.</i>	-	-	+	+	-
138	<i>Micrasterias brachyptera</i>	-	-	-	-	+
139	<i>Hyalotheca mucosa</i>	-	-	-	+	+
140	<i>Staurastrum pinnatum</i>	-	-	+	-	+
141	<i>Staurastrum bieneanum</i>	-	+	+	-	-
142	<i>Staurastrum convolutum</i>	+	-	-	+	-
143	<i>Staurastrum recurvatum</i>	-	-	-	+	-
144	<i>Staurastrum saltans</i>	-	-	+	-	+
145	<i>Staurastrum gracile</i>	-	-	-	-	+
146	<i>Staurastrum paradoxum</i>	-	-	-	-	+
147	<i>Staurastrum tetraceum</i>	-	-	-	-	-
148	<i>Staurastrum sonthalianum</i>	+	-	-	+	-
149	<i>Gonatozygon monotaenium</i>	-	-	+	+	-
150	<i>Coleochaete pulvinata</i>	-	-	+	-	-
151	<i>Glaucocystis major reproductive stage</i>	-	-	-	-	+
152	<i>Nitella sp.</i>	-	+	+	-	-
153	<i>Asterococcus sp.</i>	-	-	+	-	+
154	<i>Elakatothrix gelatinosa</i>	-	-	-	+	+
155	<i>Dictyosphaerium simplex</i>	+	+	-	-	-
156	<i>Dictyosphaerium chlorelloids</i>	+	-	+	-	-
157	<i>Trebouxia sp.</i>	+	-	-	-	+
158	<i>Chlorella vulgaris</i>	+	-	-	-	-
159	<i>Chlorella peruviana</i>	+	+	-	-	-
160	<i>Chlorella ovalis</i>	-	-	+	+	-
161	<i>Chlorella luteoviridis</i>	-	-	-	-	+
162	<i>Botryococcus braunii</i>	-	-	-	+	-
163	<i>Micractinum sp.</i>	-	-	+	-	+
164	<i>Amphikrikos minutissimus</i>	-	+	-	+	-
		37	26	58	53	70

The species diversity of a Chlorophyceae member were maximum during the period of study; the results were observed in **Table :1, Plates:1,2,3,4,5 & 6 and Fig: 2**. *Oedogonium sp.* (16), *Scenedesmus sp.* (11), *Spirogyra sp.* (16), *Cosmarium sp.* (8), and *Staurastrum sp.* (9) were recorded in the major dominant genera in the sampling stations. These dominant genera and species were *Oedogonium* young thallus, *Oedogonium sp.* *Oedogonium* macrandrous, *Oedogonium* nanandrous, *Oedogonium pectorum*, *Oedogoniumgracileus*, *Oedogonium hispidum*, *Oedogonium giganteum*, *Oedogonium globosum*, *Oedogonium anomalum*, *Oedogonium nodulosum*, *Oedogonium hindustanense*, *Oedogonium mexicanum*, *Oedogonium prinsheimii*, and *Oedogonium crispum*. *Scenedesmus incrassatulus*, *Scenedesmus quadricauda*, *Scenedesmus bijugatus var. graevenitizii*, *Scenedesmus dimorphous*, *Scenedesmus arcuatus var. capitatus*, *Scenedesmus ginzbergeri*, *Scenedesmus graevenitizii*, *Scenedesmus quadricauda var. longispina*, *Scenedesmus quadricauda var. quadrispina*, *Scenedesmus quadricauda var. westii*, and *Scenedesmus denticulatus*. *Spirogyra sp.* such as, *Spirogyra elliptica*, *Spirogyra gracilis*, *Spiogyra decimina*, *Spirogyra iyengari*, *Spirogyra fluviatilis*, *Spirogyra varians*, *Spirogyra pratensis*, *Spirogyra dentireticulata*, *Spirogyra mirabilis*, *Spirogyra punctata*, *Spirogyra longata*, *Spirogyra semiornata*, *Spirogyra chenii*, *Spirogyra minuticrassoidea*, *Spirogyra pseudomaxima*, and *Spirogyra chungkingensis*. *Cosmarium depressum*, *Cosmarium renifarme*, *Cosmarium angulosum var concinnum*, *Cosmarium divergens*, *Cosmarium pseudoretusum*, *Cosmarium moniliformae*, and *Cosmarium formosulum*. *Staurastrum sp.* were dominant such as, *Staurastrum pinnatum*, *Staurastrum bieneanum*, *Staurastrum convolutum*, *Staurastrum recurvatum*, *Staurastrum saltans*, *Staurastrum gracile*, *Staurastrum paradoxum*, *Staurastrum tetraceum*, and *Staurastrum sonthalianum* were recorded under the class chlorophyta. The present finding in confirmity with the previous report of the following, Turner (1892), West & West (1904,1905,1908,1912), West *et al.*(1923), Randhawa (1959), Ramanathan (1964), Philipose (1967), Hindak (1977,1980,1984,1988), Gonzalves (1981), Komarek & Fott (1983), Krishnamurthy (2000).Several *Ulothrix* species have been found in streams and waterfalls in India's Eastern and North-Eastern regions, according to Bhakta and Adhikary (2014).

PLATE I: LIST OF MICROALGAE COLLECTED FROM WATER FALLS I. CHLOROPHYCEAE

1 <i>Characium ambiguum</i> (Braun) Hermann	15 <i>O. giganteum</i> Kuetzing
2 <i>Characium ruberhorstii</i> De Toni	16 <i>O. globosum</i> (Link ex Hirn) Nordst
3 <i>Kirchneriella elongata</i> G.M.Smith	17 <i>O. anomalum</i> Hirn
4 <i>Kirchneriella contorta</i> (Schmidle) Bohlin	18 <i>O. nodulosum</i> Wittrock
5 <i>Chlamydomonas</i> sp. (Ehrenberg)	19 <i>O. hindustanense</i> Kamat
6 <i>Chlamydomonas reinhardtii</i> (Ehrenb) Dang	20 <i>O. mexicanum</i> Wittrock
7 <i>Oedogonium youngii</i> Thalass	21 <i>O. pinguis</i> Wittrock et Nordst
8 <i>Oedogonium youngii</i> Thalass	22 <i>O. crispum</i> (Hass) Wittrock
9 <i>Oedogonium</i> sp. Link ex Hirn With sex organ	23 <i>Haematococcus</i> sp. C.A. Agardh
10 <i>Oedogonium macrandrum</i>	24 <i>Haematococcus</i> sp. pluvialis
11 <i>Oedogonium nanandrum</i>	25 <i>Endoniria</i> sp. Ehrenberg
12 <i>O. pectorum</i> (Link ex Hirn) Nordst	26 <i>Pandorina</i> sp. Bory
13 <i>O. graciliss</i> (Witt.) Tiffany	27 <i>Asteromonas</i> sp. Artari
14 <i>O. hispidum</i> Nordstedt in Wittrock	28 <i>Asteromonas gracilis</i> Artari
	29 <i>Bulbochaete</i> sp.

PLATE II: LIST OF MICROALGAE COLLECTED FROM WATER FALLS I. CHLOROPHYCEAE

30 <i>Microspora utiformis</i> (Thuret) Lagerheim	44 <i>Pediastrum simplex</i> Meyen
31 <i>Chlotophosph attenuata</i> Braun	45 <i>Pediastrum boryanum</i> (Turpin)
32 <i>Conostictis ornata</i> var. <i>platydictis</i> (G.M.Smith) E.Hagewald & M.Wolf	46 <i>Pediastrum ovatum</i> Ehrenberg
33 <i>Ankistrodesmus arcuatus</i> Korshikov	47 <i>Selinastrum</i> sp. Reinach
34 <i>A. fusiformis</i> Corda ex Korshikov	48 <i>Selinastrum gracile</i> Reinach
35 <i>Tetraedron trigonum</i> Hanagrig	49 <i>Selinastrum bilobatum</i> Reinach
36 <i>Tetraedron regulare</i> Kuetzing	50 <i>Desmoudeus chondrus</i> (Reich) Hagewald
37 <i>Tetraedron triangulare</i> Korshikov	51 <i>Desmoudeus dispar</i> Brebisson
38 <i>T. muticum</i> (A.Braun) Hanagrig	52 <i>Desmoudeus multivariabilis</i>
39 <i>Volvox</i> sp.	53 <i>Monoraphidium</i> sp. Komarkova-Lagareva
40 <i>Hydrodictyon</i> sp. Roth	54 <i>Monoraphidium circinale</i> (Bygaard) Bygaard
41 <i>H. reticulatum</i> (L.) Lagerheim	55 <i>Coelastrum intermedium</i> (Bohlin) West
42 <i>Pediastrum duplex</i> Meyen	56 <i>Palmelloccocus anochrophilus</i> (Kruenger) Chodat
43 <i>P. duplex</i> var. <i>clathratum</i> (A.Braun) Lagerheim	

PLATE III: LIST OF MACROALGAE COLLECTED FROM WATER FALLS I. CHLOROPHYCEAE

57 <i>Acutodesmus obliquus</i> Hagewald & Hanagrig	71 <i>S. quadricauda</i> var. <i>quadrifurcata</i> (Chodat) G.M.Smith
58 <i>Gongostira fluminensis</i> Kuetzing	72 <i>S. quadricauda</i> var. <i>westii</i> G.M.Smith
59 <i>Tetraspora gelatinosa</i> (Vaucher) Desvaux	73 <i>S. denticulatus</i> Lagerheim
60 <i>Stigeoclonium tenue</i> C.A. Agardh	74 <i>Stigeoclonium locostri</i> (Chod) G.M.Smith
61 <i>Chlorococcum infusum</i> (Schr.) Menegh	75 <i>Microglona cociferu</i> Ehrenberg 1832
62 <i>C. hamicola</i> (Nageli) Rothenhorst	76 <i>M. hastinaculata</i> Ehrenberg
63 <i>Scenedesmus incrassatus</i> Bohlin	77 <i>M. charikovensis</i> Ehrenberg 1832
64 <i>S. quadricauda</i> Brebisson	78 <i>Phycopeltis</i> sp. Millardet
65 <i>S. hirsutus</i> var. <i>greenii</i> (Turpin) Kuetzing	79 <i>Ulothrix cylindrica</i> Prescott
66 <i>Scenedesmus dimorphus</i> (Turpin) Kuetzing	80 <i>U. substricta</i> G.S. West
67 <i>S. arcuatus</i> var. <i>capitata</i> Lemmermann	81 <i>U. variabilis</i> Kuetzing
68 <i>S. glazbergii</i> Kammerer	82 <i>U. zonata</i> (Weber & Mohr) Kuetzing
69 <i>S. graevenitzi</i> (Bernard) Chodat	83 <i>Cladophora glomerata</i> Linnaeus
70 <i>S. quadricauda</i> var. <i>longispina</i> (Chodat) G.M.Smith	84 <i>C. oligocoma</i> Kuetzing

PLATE IV: LIST OF MICROALGAE COLLECTED FROM WATER FALLS I. CHLOROPHYCEAE

85 <i>Rhizoclonium hieroglyphicum</i> (C.Agal) Kutz.	99 <i>S. longata</i> (Vaucher) Kuetzing
86 <i>R. tortuosum</i> (Dillwyn) Kuetzing	100 <i>S. semiornata</i> Jao
87 <i>R. ramosum</i> Z. Zhou et G.J. Liu	101 <i>S. chenii</i> , Jao
88 <i>R. riparium</i> (Bohlin) Harvey	102 <i>S. minutissima</i> Yonezaki
89 <i>Spirirogona elliptica</i> C. C. Jan	103 <i>S. pseudonovata</i> (Hassal) Wittrock
90 <i>S. gracilis</i> (Hassal) Kuetzing	104 <i>Spirirogona changkangensis</i> Jao
91 <i>S. decurva</i> (Muller) Kuetzing	105 <i>Mougeotia</i> sp. C.A. Agardh
92 <i>S. iyengarii</i> Kuetzing	106 <i>Mougeotia elegantula</i> Wittrock
93 <i>S. flavitilis</i> Hise	107 <i>Mougeotia varians</i> (Wittrock) Curda
94 <i>S. varians</i> (Hassal) Kuetzing	108 <i>Mougeotia tamuliana</i> Transeau
95 <i>S. pratensis</i> Transeau	109 <i>Cosmarium depressum</i> (Nageli) P.Landell
96 <i>S. dentriculata</i> Jao	110 <i>C. reniforme</i> (Ralfs) Archer
97 <i>S. mirabilis</i> (Hassal) Kuetzing	111 <i>C. angulosum</i> Brebisson

PLATE V: LIST OF MICROALGAE COLLECTED FROM WATER FALLS I. CHLOROPHYCEAE

113 <i>Cosmarium divergens</i> Krieger	127 <i>Euastrum anatum</i> Ehrenberg
114 <i>C. pseudoretatum</i> Duell	128 <i>Desmidium elegans</i> C. Agard ex Ralfs
115 <i>C. moniliforme</i> (Turpin) Ralfs	129 <i>Desmidium bailyi</i> (Thal) Nordst
116 <i>Cosmarium formosulum</i> Hoff	130 <i>Pantium spinospermum</i> Joshua
117 <i>Phlebotanidium maculatum</i> (Turner) Carter	131 <i>Actinostanidium diplosporum</i> (P.Landell) Tilling
118 <i>F. ovatum</i> Nordst	132 <i>Xanthidium sexannulatum</i> West & West
119 <i>F. trabecula</i> (Ehr) Nageli	133 <i>Zygnema terrestris</i> Bandhava
120 <i>Closterium isobelinii</i> Kut. ex Ralfs	134 <i>Zygnema cylindricum</i> C.A. Agardh
121 <i>Closterium venus</i> Kuetzing	135 <i>Zygnema ovoidanum</i> C.A. Agardh
122 <i>Closterium littorale</i> P. Gay	136 <i>Zygnema cruciatum</i> (Vauch) Agardh
123 <i>C. cf. prolongum</i> Vaz brevius (Nordst) W. Krieger	137 <i>Cylindrocapsa</i> sp. De Bary
124 <i>C. prichardianum</i> W. Archer	138 <i>Micrasterias brachyptera</i> P.Lande
125 <i>C. Janula</i> (Muller) Nitsch	139 <i>Hyalotheca mucosa</i> (Dillw.)
126 <i>Euastrum ocellanicum</i> Krieger	140 <i>Staurastrum pinatum</i> Krieger

PLATE VI: LIST OF MICROALGAE COLLECTED FROM WATER FALLS I. CHLOROPHYCEAE

141 <i>Staurastrum bieneanum</i> Rothenhorst	155 <i>Dictyosporium simplex</i> Korshikov
142 <i>Staurastrum convolutum</i> Meyen ex Ralfs	156 <i>Dictyosporium chlorellioides</i>
143 <i>Staurastrum recurvatum</i> Turner	157 <i>Trebouxia</i> sp. Pymaly
144 <i>Staurastrum salutum</i> Scott & Prescott	158 <i>Chlorella vulgaris</i> Beijerinck
145 <i>Staurastrum gracile</i> Ralfs	159 <i>Chlorella peruviana</i> Beijerinck
146 <i>Staurastrum paradoxum</i> Ralfs	160 <i>Chlorella ovalis</i> Butcher
147 <i>Staurastrum tetrastrum</i> Ralfs ex Ralfs	161 <i>Chlorella lateoviridis</i> Chodat
148 <i>Staurastrum sonthalakanum</i> Turner	162 <i>Botryococcus braunii</i> Kuetzing
149 <i>Gonatozygon monotonium</i> De Bary	163 <i>Microcystium</i> sp. Fresenius
150 <i>Coelaechate pulvinata</i> A. Braun	164 <i>Amphikrikos minutissimus</i> Korshikov
151 <i>Glaucochaete major</i> reproductive stage	
152 <i>Nitella</i> sp. C.A. Agardh	
153 <i>Asterococcus</i> sp. Scherfel	
154 <i>Elakotobrix gelatinosa</i> Wille	

5. CONCLUSION

In this present study, algae identification was used in a dichotomous key (Bracketed key) within the Chlorophyceae. A total of 164 taxa of chlorophyceae, belonging to 61 genera and 32 families, were recorded. The number of species in five different sampling stations, S1(37), S2(26), S3(58), S4(53), and S5(70) was recorded. Of these, S5 (New falls or Main falls) showed the maximum number and best suitable for microalgal growth. Present New findings conclude as follows: waterfalls are the best ecosystem for microalgal growth and diversity, because of atmospheric moisture, pH, rocky substratum, solid substances like inflow of sediment, silt through running water was rich in organic matter, and other environmental conditions. In India, 16 waterfalls were documented in this field of research; the present research report is the 17th waterfall as a new report.

6. References: -

- 1) Aleena, M & Chitra, G 2022, Seasonal variations of microalgal distribution and physico- chemical parameters of ponds in perinjannam panchayath, Thrissur district, Kerala, India, Journal of Emerging Technologies and Innovative Research (JETIR), Volume 9, Issue 4.
- 2) and North-Eastern region of India, Nelumbo, 56, pp. 291-341.
- 3) Barinova, SS, Tavassi, M & Nevo, E 2006, Diversity and Ecology of Algae from the Alexander River (Central Israel) FI-Medit. 16, pp.111-132,
- 4) Barsanti L, Gualtieri P.2022, Algae: Anatomy, Biochemistry, and Biotechnology, 3rd ED. CRC Press Taylor & Francis Group, United States.
- 5) Bhakta, SK & Adhikary, SP 2014, Algal diversity in the streams and Waterfalls of Eastern
- 6) Bold, H.C. & Wynne, M.J. 1978. Introduction to the Algae. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 573 pp.
- 7) Borowitzka, MA 2018, Biology of Microalgae, Editors(s): Levine IA, Florence J; Microalgae in Health and Disease Prevention. pp: 23-72.
- 8) FB Metting Jr, 1996, Biodiversity and application of microalgae, Journal of Industrial Microbiology, 17, pp. 477-489
- 9) Fritsch, F.E.(1984 & 1985). Text Book of Algae .Vol:I &II., Oxford IBH Publishing Pvt, London.
- 10) Gonzales, EA 1981, Oedogoniales, Indian Council for Agricultural Research, New Delhi. pp. 757.
- 11) Guiry GM 2023, AlgaeBase. World wide electronic publication, National University of Ireland, Galway.
- 12) Hindak, F 1977, Studies of the Chlorococcal algae (Chlorophyceae), I- Biologicke Prace 23(4): pp. 1-190.

- 13) Hindak, F 1980, Studies of the Chlorococcal algae (Chlorophyceae), II- Biologicke Prace 26(6): pp. 1-195.
- 14) Hindak, F 1984, Studies of the Chlorococcal algae (Chlorophyceae), III- Biologicke Prace 30(1): pp. 1-308.
- 15) Hindak, F 1988, Studies of the Chlorococcal algae (Chlorophyceae), IV- Biologicke Prace 34(1-2): pp. 1-262.
- 16) Komarek, J & Fott, B 1983, Das phytoplankton des subwassers, 7. Teil: E. Schweizerbart's Che Verlags-buchhandlung, Stuttgart: pp. 1001.
- 17) Krishnamoorthy, V 2000, Algae of India and Neighbouring Countries I. Chlorophycota Oxford and IBH Publisher, New Delhi: pp. 210.
- 18) Philipose, MT 1967, Chlorococcales, Indian Council of Agricultural Research, New Delhi. pp. 365.
- 19) Ramanathan, KR 1964, Ulotricales, Indian Council of Agricultural research, New Delhi, pp. 188.
- 20) Randhawa, MS 1959, Zygnemataceae, Indian Council Agricultural Research, New Delhi. Pp: 478. Society, London. Pp. 194.
- 21) Turner, WB 1892, The freshwater algae (principally Desmidiaceae of East India), Royal Swedish Acad. Sci. Stockholm, Pp. 187.
- 22) Uday Bhan Singh and Sharma, 2014, Microalgal diversity of Sheer Khad (stream): a tributary of Sutlej River, Himachal Pradesh, India, Journal of Research in Plant Sciences, 3(1), pp: 235-241.
- 23) Victoria Anand Mary, A, Prabakaran, G & Mohan, S 2018, Fresh water microalgae image identification and classification based on Machine Learning Technique, Asian Journal of Computer Science and Technology Vol.7 No.31: pp. 63-67.
- 24) Wafaa Odeh, Mais Sweiss, Fatima Haj Ahmad, Zeinab Arabeyyat, Waed Alnsour, Marah Aldabbas and Maen Hasan, 2023, Isolation and Identification of green microalgae from Northern Jordan, Journal of Pure Applied Microbiology, pp: 2205-2214.
- 25) Wehr, JD & Sheath, RG (Eds) 2003, Freshwater algae of North America Ecology and Classification, San Diego, California Journal of Applied Phycology 4(3): pp. 267-279.
- 26) West, W & West, GS 1904, A Monograph of the British Desmidiaceae. Vol. I. The Ray Society, London. Pp. 1-224.
- 27) West, W & West, GS 1905, A monograph of the British Desmidiaceae. Vol II. The Ray Society, London. Pp. 1-204.
- 28) West, W & West, GS 1908, Algae from Austwick Moss, North Yorkshire, Naturalist, Hull 1908 (614): pp. 101-103.
- 29) West, W, and West, GS 1912, A Monograph of the British Desmidiaceae. Vol. IV, The Ray
- 30) West, W, West, GS & Carter, N 1923, A monograph of the British Desmidiaceae, Vol.5, The Ray Society, London. pp. 300.

Acknowledgements: The authors are very grateful to the authorities of Sri Parasakthi College for Women, Courtallam and Mamonmaniam Sundaranar University, Tirunelveli, who permitted us to do our research work successfully.

