

Taxonomic Key to Identify the Fresh Water Microalgae from “Water Falls”: Focus to Chlorophycean Member

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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*.

Key words: Freshwater algae, Courtallam, Chlorophyceae, Phylogenetic diversity

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 [24]. 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, [5] ranging from microscopic unicellular to multicellular giant organisms such as kelp [3]. Approximately 60,000 species are documented in Algae Base, with approximately 55,000 of them being eukaryotic algae. Among them, 13,000 species are green algae, including chlorophytes and charophytes [11]. 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 and 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 [26].

MATERIALS AND METHODS

Study area

In the present study, five sample collection sites (S₁ to S₅) were selected on Courtallam. 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).

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. Microalgae were collected in sampling bottles and 4% formaldehyde was added to preserve the samples.

Bracketed key [19]

A bracketed key is a type of dichotomous key in taxonomy where the alternative choices of a couplet are presented side-by-side, often numbered or lettered, allowing for easy comparison and forward or backward movement through the key using the indicated numbers. Unlike indented keys, the relationships between choices are less apparent, but bracketed keys are space-efficient and commonly used for identifying specimens.

Characteristics of a bracketed key side-by-side choices: The defining feature is that both opposing characters in a couplet are placed next to each other for direct comparison.

Numbered / Lettered options: Each choice within a couplet is given a number or letter, which directs the user to the next relevant couplet.

Forward and backward navigation: Following the numbers allows users to move both forward through the key to the next identification step and backward if they need to correct a choice.

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Space efficiency: They are considered economical in space compared to other key types.

Advantages

Readability: The side-by-side format makes comparing alternatives quick and easy.

Flexibility: Users can easily move forward and backward through the key by following the numbers, which can help in re-evaluating choices.

Disadvantages

Less visual hierarchy: The relationship between different divisions of the key is not as apparent as with an indented key.

Complexity of construction: Creating a complex bracketed key can be more involved.

How to use a bracketed key

Start at the beginning: Begin at the first couplet, which is a pair of contrasting characteristics.

Compare characters: Examine the specimen and determine which of the two options in the first couplet applies to it.

Follow the number: Select the corresponding number or letter indicated for that choice.

Repeat: Continue making choices at each numbered step until the specimen is identified.

Navigate backwards: If you suspect a mistake was made, you can use the numbers to go back to a previous couplet and try a different option.

Key to the species

Chlorophyceae

Step No.	Description / Character	Species / Leads to
1a	Cell body ellipsoidal or spindle-shaped	<i>Characium ambiguum</i> (1)
1b	Cells elongate, fusiform or lanceolate	(2)
2a	Colonies composed of 16	<i>Kitchneriella elongata</i> (3)
2b	Colonies of 4,8,16 or 32 cells	<i>Kitchneriella contorta</i> (4)
3a	Flagellum shows a typical 9+2 arrangement of the component fibrils	(5)
3b	A large cup-shaped chloroplast and pyrenoid	<i>Chlamydomonas reinhardi</i> (6)
4a	Chloroplasts parietal and net-like appearance	(7-11)
4b	A root-like hold fast, contains a net-like chloroplast	<i>Oedogonium pectorum</i> (12)
5a	Vegetative cells cylindrical, 20-25 µm in diameter	<i>Oedogonium gracilius</i> (13)
5b	Vegetative cells cylindrical, 9-14 µm in diameter	(14)
6a	Vegetative cells cylindrical 65-200-(225) µm long	<i>Oedogonium gigantium</i> (15)
6b	Vegetative cells cylindrical 30-50 µm long	<i>Oedogonium globosum</i> (16)
7a	Oogonia solitary; subovoid or cylindrical	(17)
7b	Vegetative cells with 2 prominent undulations and constrictions	<i>Oedogonium nodulosum</i> (18)
8a	Vegetative cells 15-25 µm in diameter	(19)
8b	Vegetative cells 34-41 µm in diameter	<i>Oedogonium mexicanum</i> (20)
9a	It is a macrandrous, heterothallic	<i>Oedogonium pringsheimii</i> (21)
9b	It is a macrandrous, homothallic	<i>Oedogonium crispum</i> (22)
10a	2 widely diverging flagella from an anterior papilla	(23)
10b	The flagella are unusual in possessing a thin tomentum of fine hairs	<i>Haematococcus pluvialis</i> (24)
11a	Chloroplast cup-shaped and parietal	<i>Eudorina</i> sp. (25)
11b	A large cup-shaped chloroplast	<i>Pandorina</i> sp. (26)
12a	Single-celled motile organism	<i>Asteromonas</i> sp. (27)
12b	Unicellular planktonic chlorophyte without a cell wall	(28)
13a	Uniseriate filaments with extensive unilateral branching	<i>Bulbochaete</i> sp. (29)
13b	Cell body 10-12 µm in diameter and 13-18 µm long	<i>Microspora williana</i> (30)
14a	Filaments usually dichotomously branched	(31)
14b	Outer cells not fully aligned parietal chloroplast	<i>Cosmaseilla arcuata</i> var. <i>platydisca</i> (32)
15a	Single parietal chloroplast without pyrenoids	(33)
15b	Cells 4-6 µm broad and 20-50 µm long	<i>Ankistrodesmus fusiformis</i> (34)
16a	Cell membrane smooth	<i>Tetraedron trigonum</i> (35)
16b	Tetragonal cells, pyramidal	(36)
17a	Cells 14-16 µm in diameter	<i>Tetraedron triangulare</i> (37)
17b	Cells 6-30 µm in diameter	(38)
18a	Polypyletic genus in the volvocine green algae	<i>Volvox</i> sp. (39)
18b	Cells are coenocytic and multinucleate	<i>Hydrodictyon</i> sp. (40)
19a	Colonies reticulate	(41)
19b	Colonies free floating, flat	<i>Pediastrum duplex</i> (42)
20a	Colonies 8-64 celled	(43)
20b	Colonies 4-8-16-32 or more cells	<i>Pediastrum simplex</i> (44)
21a	Coenobia 120-124 µm in diameter	(45)
21b	Marginal cells convex with single projection	<i>Pediastrum ovatum</i> (46)
22a	Chloroplast single, parietal	(47)
22b	Chloroplast parietal without pyrenoid	<i>Selenastrum gracile</i> (48)
23a	Chloroplast single, parietal and usually with a pyrenoid	(49)

23b	Cells 6-15 µm broad	(50)
24a	Cells 17 µm long and 5 µm wide	<i>Desmodesmus dispar</i> (51)
24b	Colonies of 2,4,8 or 16 cells arranged in a row	<i>Desmodesmus multivariabilis</i> (52)
25a	Single cells, fusiform, cylindrical	(53)
25b	Cells solitary, fusiform	<i>Monoraphidium circinale</i> (54)
26a	Colony spherical 62-67.5 µm in diameter	<i>Coelastrum intermedium</i> (55)
26b	Cell membrane thin, colorless and slimy	(56)
27a	Colony 4 celled and fusiform	<i>Acutodesmus obliquus</i> (57)
27b	Growing on wood and old shells	<i>Gongrosira fluminensis</i> (58)
28a	Cells 2.5-13 µm in diameter	(59)
28b	Parietal chloroplasts with 4-7 pyrenoids	<i>Stigeoclonium tenue</i> (60)
29a	Parietal chloroplasts with a single pyrenoid	(61)
29b	Cells 4.5 µm broad and 3-4 µm long	(62)
30a	Cells 5-10 µm broad and 12-28 µm long	<i>Scenedesmus incrassatulus</i> (63)
30b	Coenobia 4-celled, cells 16.1 µm long and 4.6 µm broad	<i>Scenedesmus quadricauda</i> (64)
31a	Cells 7-8 µm long and 2 µm broad	<i>Scenedesmus bijugatus</i> var. <i>graevenitzii</i> (65)
31b	Colonies 7-8 celled	<i>Scenedesmus dimorphous</i> (66)
32a	Colonies usually 8 celled rarely 4-16 celled	(67)
32b	Colonies usually 8 celled rarely 4-celled	<i>Scenedesmus ginzbergeri</i> (68)
33a	Colony 4-8 celled	<i>Scenedesmus graevenitzii</i> (69)
33b	Spines 7.5-15 µm long	(70)
34a	Spines 2.5-5.5 µm long	<i>Scenedesmus quadricauda</i> var. <i>quadrispina</i> (71)
34b	Colony composed of 4-8 oval cells	(72)
35a	Cells 4-11 µm broad and 6-17 µm long	<i>Scenedesmus denticulatus</i> (73)
35b	Cells 3-5 µm in diameter and 20-25 µm long	<i>Quadrigula lacustris</i> (74)
36a	Cell wall thick with large	<i>Microglena coccifera</i> (75)
36b	Chloroplast 2 cup-shaped	(76)
37a	Cells 10-16.5 µm in diameter and 8-14.5 µm long	(77)
37b	Dichotomously branched filaments	<i>Phycopeltis</i> sp. (78)
38a	Cells elongate, cylindrical	<i>Ulothrix cylindricum</i> (79)
38b	Filaments planktonic, composed of slightly inflated cells	(80)
39a	Pyrenoids 6-7; nucleus 1	<i>Ulothrix variabilis</i> (81)
39b	Pyrenoids 6-8; nucleus 1	<i>Ulothrix zonata</i> (82)
40a	Cells 250 µm long and 20-60 µm broad	<i>Cladophora glomerata</i> (83)
40b	Cells 45-55 µm in diameter	(84)
41a	Nucleus 7-8, pyrenoids 4-8	(85)
41b	Cell wall fairly thick, distinctly stratified	<i>Rhizoclonium tortuosum</i> (86)
42a	Thalli clustered about 1-2.5 cm long	<i>Rhizoclonium ramosum</i> (87)
42b	Chloroplast coarsely reticulate with numerous pyrenoids	(88)
43a	Cells are cylindrical the chloroplasts are 1-16	<i>Spirogyra elliptica</i> (89)
43b	Chloroplast 1 making 1-2 turns	<i>Spirogyra gracilis</i> (90)
44a	Chloroplast 2-3, 1-2 turns	(91)
44b	Chloroplasts form a distinct spiral band within the cell	(92)
45a	Vegetative cell cylindrical, 20-60 µm broad and 40-192 µm long	<i>Spirogyra fluviatilis</i> (93)
45b	Chloroplast solitary, making ½-4 turns	<i>Spirogyra varians</i> (94)
46a	Chloroplast 1 and 1-8 turns	(95)
46b	End wall replicate	(96)
47a	Fertile cells inflated	<i>Spirogyra mirabilis</i> (97)
47b	Chloroplast 1 with 5-7 turns, end wall plane	<i>Spirogyra punctate</i> (98)
48a	Vegetative cells 19-27 µm x 99-165 µm	<i>Spirogyra longata</i> (99)
48b	Filaments of vegetative cells cylindrical	(100)
49a	Single chloroplast with 3-5 turns	<i>Spirogyra chenii</i> (101)
49b	Gametangia cylindrical in shape	(102)
50a	Width 135-140 µm in diameter and 190-430 µm long	<i>Spirogyra pseudomaxima</i> (103)
50b	Width 24-27 µm in diameter and 150-300 µm long	<i>Spirogyra chungkingensis</i> (104)
51a	Filaments unbranched	<i>Mougeotia</i> sp. (105)
51b	Filaments very slender	(106)
52a	Vegetative cells 25-27 µm in diameter	<i>Mougeotia varians</i> (107)
52b	Vegetative cells 6-8 µm in diameter	(108)
53a	Cells slightly broader than long	<i>Cosmarium depressum</i> (109)
53b	Cells longer than broad	(110)
54a	Cells 37-39 µm broad and 24-27 µm long	<i>Cosmarium angulosum</i> (111)
54b	Cells 11.5-16.81 µm long and 9.5-15.42 µm in diameter	(112)
55a	Cell deeply constricted	<i>Cosmarium divergens</i> (113)
55b	Cells longer than broad	<i>Cosmarium pseudoretusum</i> (114)
56a	Isthmus 7.36-9.47 µm broad	(115)

56b	Isthmus 10.8-11.6 µm wide	<i>Cosmarium formosulum</i> (116)
57a	Cells 686-756 µm long and 40-55 µm broad	(117)
57b	Cell body 230 µm long	<i>Pleurotaenium ovatum</i> (118)
58a	Cell body 260-660 µm long	(119)
58b	Cell length 190-200 µm	<i>Closterium leibleinii</i> (120)
59a	Cell body small, strongly curved	<i>Closterium venus</i> (121)
59b	Cell length 275-295 µm	<i>Closterium littorale</i> (122)
60a	Cell length 200-330 µm	(123)
60b	Cell breadth 35-40 µm	(124)
61a	Chloroplasts with many pyrenoids	<i>Closterium lunula</i> (125)
61b	Isthmus 8 µm broad	<i>Euastrum ceylanicum</i> (126)
62a	Isthmus 15 µm broad	<i>Euastrum ansatum</i> (127)
62b	Cells 3-5 angled or elliptical in apical view	<i>Desmidium elegans</i> (128)
63a	Cells 16 µm long, 21 µm wide	(129)
63b	Cells 25-30 µm long and 10-15 µm broad	<i>Penium spinospermum</i> (130)
64a	Chloroplast asteroid	<i>Actinotaenium diplosporum</i> (131)
64b	Isthmus 12-13 µm	(132)
65a	It is a brittle worst or stone worst	<i>Zygnema terrestre</i> (133)
65b	Conjugation mostly scalariform	<i>Zygnema cylindricum</i> (134)
66a	Chloroplasts 2, axial, stellate masses, contains a large central pyrenoid	<i>Zygnema ovedanum</i> (135)
66b	Vegetative cells are 32-39 µm in width and 35-50 µm in length	(136)
67a	Cell body cylindrical or spindle-shaped	<i>Cylindrocystis sp.</i> (137)
67b	Cells in rough outline ellipsoid	<i>Micrasterias brachyptera</i> (138)
68a	Cell body 12.8-13.6 µm long	<i>Hyalotheca mucosa</i> (139)
68b	Cell is small in size	<i>Staurastrum pinnatum</i> (140)
69a	Cells slightly broader than long	(141)
69b	Chloroplast usually one per semicell	<i>Staurastrum convolutum</i> (142)
70a	Cells radially symmetrical	<i>Staurastrum recurvatum</i> (143)
70b	Isthmus 10-11 µm	<i>Staurastrum saltans</i> (144)
71a	Vertical view of the cell is triangular	<i>Staurastrum gracile</i> (145)
71b	Semicells companulate or cup-shaped	(146)
72a	Cells 7-10 µm long	(147)
72b	Cells 39-48 µm long	<i>Staurastrum sonthalianum</i> (148)
73a	2 chloroplasts with 4-10 pyrenoids in each	<i>Gonatozygon monotaenium</i> (149)
73b	The plant body may be homothallic	<i>Coleochaete pulvinata</i> (150)
74a	Reproduction by autospores	(151)
74b	Mature plants 30-100 cm high	<i>Nitella sp.</i> (152)
75a	Cells globose or sub-globose	<i>Asterococcus sp.</i> (153)
75b	Colonies free-floating	(154)
76a	Cells 8 µm in diameter, 13 µm long	<i>Dictyosphaerium simplex</i> (155)
76b	The pyrenoid was surrounded by several (5-6) starch grains	<i>D. chlorelloids</i> (156)
77a	Cocoid algae found in lichen thallus	(157)
77b	Cell 6.4 µm in diameter	<i>Chlorella vulgaris</i> (158)
78a	Chloroplast a parietal cup or merely a plate	<i>Chlorella peruviana</i> (159)
78b	Reproduction occurs through forming eight autospores	<i>Chlorella ovalis</i> (160)
79a	Cells always spherical	(161)
79b	Cells 3-6 µm in diameter, 6-15 µm long	<i>Botryococcus braunii</i> (162)
80a	Cell contains a single cup-shaped chloroplast with 1 pyrenoid	<i>Micractinium sp.</i> (163)
80b	Cells solitary or arranged in 4-8 celled autosporangia	<i>Amphikrikos minutissimus</i> (164)

RESULTS AND DISCUSSION

In the present study 164 taxa have been identified from waterfalls in (Table 1). In These taxa were present or absent at

different sampling stations. Identification of algal taxa was done using diagnostic dichotomous keys, based mainly on simple morphological characters in description of chlorophyceae.

Table 1 List of Chlorophycean micro algae collected from water fall

S. No.	Binomial	Class	Order	Family	Species distribution in sampling stations					
					S ₁	S ₂	S ₃	S ₄	S ₅	Total
1	<i>Characium ambiguum</i>	Chlorophyceae	Sphaeropleales	Characiaceae	-	-	+	-	-	1
2	<i>Characium rabenhorstii</i>	Chlorophyceae	Sphaeropleales	Characiaceae	-	-	-	-	+	2
3	<i>Kitchneriella elongate</i>	Chlorophyceae	Sphaeropleales	Selenastraceae	-	-	+	-	-	1
4	<i>Kitchneriella contorta</i>	Chlorophyceae	Sphaeropleales	Selenastraceae	-	-	-	-	+	1
5	<i>Chlamydomonas sp.</i>	Chlorophyceae	Chlamydomonadales	Chlamydomonadaceae	+	+	-	-	-	2
6	<i>Chlamydomonas reinhardi</i>	Chlorophyceae	Chlamydomonadales	Chlamydomonadaceae	+	-	+	-	+	3
7	<i>Oedogonium young thallus</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	+	-	-	+	2
8	<i>Oedogonium young thallus</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	+	-	-	-	-	1
9	<i>Oedogonium sp. with sex organ</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	-	-	-	+	1

10	<i>Oedogonium macrandrous</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	-	-	-	+	1
11	<i>Oedogonium nanandrous</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	-	-	-	+	1
12	<i>Oedogonium pectorum</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	-	-	+	-	1
13	<i>Oedogonium gracilius</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	+	-	+	-	+	3
14	<i>Oedogonium hispidum</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	+	-	+	-	2
15	<i>Oedogonium giganteum</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	-	+	-	+	1
16	<i>Oedogonium globosum</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	-	-	+	-	1
17	<i>Oedogonium anomalum</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	-	-	-	+	1
18	<i>Oedogonium nodulosum</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	-	-	+	+	1
19	<i>Oedogonium hindustanense</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	-	+	-	+	2
20	<i>Oedogonium mexicanum</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	-	+	-	-	1
21	<i>Oedogonium pringsheimii</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	-	+	-	-	1
22	<i>Oedogonium crispum</i>	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	-	-	+	+	2
23	<i>Haematococcus</i> sp.	Chlorophyceae	Chlamydomonadales	Haematococcaceae	-	-	+	+	-	2
24	<i>Haematococcus pluvialis</i>	Chlorophyceae	Chlamydomonadales	Haematococcaceae	-	-	-	-	+	1
25	<i>Eudorina</i> sp.	Chlorophyceae	Chlamydomonadales	Volvocaceae	-	+	+	-	-	2
26	<i>Pandorina</i> sp.	Chlorophyceae	Chlamydomonadales	Volvocaceae	-	-	-	+	+	2
27	<i>Asteromonas</i> sp.	Chlorophyceae	Asteromonadales	Asteromonadaceae	-	-	-	-	+	1
28	<i>Asteromonas gracilis</i>	Chlorophyceae	Asteromonadales	Asteromonadaceae	+	-	-	-	-	1
29	<i>Bulbochaete</i> sp.	Chlorophyceae	Oedogoniales	Oedogoniaceae	-	-	-	+	+	2
30	<i>Microspora willeana</i>	Chlorophyceae	Sphaeropleales	Microsporaceae	-	-	-	-	+	1
31	<i>Chaetophora attenuate</i>	Chlorophyceae	Chaetophorales	Chaetophoraceae	-	+	-	-	-	1
32	<i>Comasiella arcuata</i> var. <i>platydisca</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	-	-	+	1
33	<i>Ankistrodesmus arcuatus</i>	Chlorophyceae	Sphaeropleales	Selenastraceae	-	-	-	-	+	1
34	<i>Ankistrodesmus fusiformis</i>	Chlorophyceae	Sphaeropleales	Selenastraceae	-	-	+	-	-	1
35	<i>Tetraedron trigonum</i>	Chlorophyceae	Sphaeropleales	Hydrodictyaceae	-	-	-	-	+	1
36	<i>Tetraedron regulare</i>	Chlorophyceae	Sphaeropleales	Hydrodictyaceae	-	-	-	+	-	1
37	<i>Tetraedron triangulare</i>	Chlorophyceae	Sphaeropleales	Hydrodictyaceae	-	-	+	-	-	1
38	<i>Tetraedron muticum</i>	Chlorophyceae	Sphaeropleales	Hydrodictyaceae	-	+	-	-	+	2
39	<i>Volvox</i> sp.	Chlorophyceae	Chlamydomonadales	Volvocaceae	+	-	+	+	-	3
40	<i>Hydrodictyon</i> sp.	Chlorophyceae	Sphaeropleales	Hydrodictyaceae	-	-	-	-	+	1
41	<i>Hydrodictyon reticulatum</i>	Chlorophyceae	Sphaeropleales	Hydrodictyaceae	-	-	+	-	-	1
42	<i>Pediastrum duplex</i>	Chlorophyceae	Sphaeropleales	Hydrodictyaceae	-	-	-	+	-	1
43	<i>Pediastrum duplex</i> var. <i>clathratum</i>	Chlorophyceae	Sphaeropleales	Hydrodictyaceae	-	-	-	-	+	1
44	<i>Pediastrum simplex</i>	Chlorophyceae	Sphaeropleales	Hydrodictyaceae	-	+	-	-	+	2
45	<i>Pediastrum boryanum</i>	Chlorophyceae	Sphaeropleales	Hydrodictyaceae	-	-	+	+	-	2
46	<i>Pediastrum ovatum</i>	Chlorophyceae	Sphaeropleales	Hydrodictyaceae	-	-	-	-	+	1
47	<i>Selenastrum</i> sp.	Chlorophyceae	Sphaeropleales	Selenastraceae	-	-	+	-	-	1
48	<i>Selenastrum gracile</i>	Chlorophyceae	Sphaeropleales	Selenastraceae	-	+	-	+	-	2
49	<i>Selenastrum bibrasianum</i>	Chlorophyceae	Sphaeropleales	Selenastraceae	-	-	+	+	-	2
50	<i>Desmodesmus abundans</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	-	-	+	1
51	<i>Desmodesmus dispar</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	+	-	-	1
52	<i>Desmodesmus multivariabilis</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	-	-	+	1
53	<i>Monoraphidium</i> sp.	Chlorophyceae	Sphaeropleales	Selenastraceae	+	-	-	+	-	2
54	<i>Monoraphidium circinale</i>	Chlorophyceae	Sphaeropleales	Selenastraceae	-	-	-	-	+	1
55	<i>Coelastrum intermedium</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	-	+	-	1
56	<i>Palmellocooccus saccharophilus</i>	Chlorophyceae	Chlamydomonadales	Palmellopsidaceae	-	+	-	-	+	2
57	<i>Acutodesmus obliquus</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	-	-	+	1
58	<i>Gongrosira fluminensis</i>	Chlorophyceae	Chaetophorales	Chaetophoraceae	-	-	+	-	+	2
59	<i>Tetraspora gelatinosa</i>	Chlorophyceae	Chlamydomonadales	Tetrasporaceae	-	-	-	+	-	1
60	<i>Stigeoclonium tenue</i>	Chlorophyceae	Chaetophorales	Chaetophoraceae	-	-	+	-	-	1
61	<i>Chlorococcum infusioenum</i>	Chlorophyceae	Chlamydomonadales	Chlorococcaceae	-	+	-	-	-	1
62	<i>Chlorococcum humicola</i>	Chlorophyceae	Chlamydomonadales	Chlorococcaceae	+	-	-	-	+	2
63	<i>Scenedesmus incrassatulus</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	+	-	+	-	-	2
64	<i>Scenedesmus quadricauda</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	+	-	+	-	+	3
65	<i>Scenedesmus bijugatus</i> var. <i>graevenitzi</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	+	-	-	-	1
66	<i>Scenedesmus dimorphous</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	+	+	-	2
67	<i>Scenedesmus arcuatus</i> var. <i>capitatus</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	-	-	+	1
68	<i>Scenedesmus ginzbergeri</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	-	+	-	1
69	<i>Scenedesmus graevenitzi</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	-	-	+	1
70	<i>Scenedesmus quadricauda</i> var. <i>longispina</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	+	-	-	1
71	<i>Scenedesmus quadricauda</i> var. <i>quadrispina</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	-	+	-	1
72	<i>Scenedesmus quadricauda</i> var. <i>westii</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	+	-	-	1
73	<i>Scenedesmus denticulatus</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	-	-	-	+	1
74	<i>Quadrigula lacustris</i>	Chlorophyceae	Sphaeropleales	Scenedesmaceae	-	+	-	-	+	2
75	<i>Microglena coccifera</i>	Chlorophyceae	Chlamydomonadales	Chlamydomonadaceae	-	-	+	+	-	2
76	<i>Microglena basinucleata</i>	Chlorophyceae	Chlamydomonadales	Chlamydomonadaceae	-	-	-	-	+	1
77	<i>Microglena charkoviensis</i>	Chlorophyceae	Chlamydomonadales	Chlamydomonadaceae	-	+	-	-	-	1
78	<i>Phycopeltis</i> sp.	Ulvophyceae	Trentepohliales	Trentepohliaceae	-	-	+	-	+	2
79	<i>Ulothrix cylindricum</i>	Ulvophyceae	Ulotrichales	Ulotrichaceae	+	-	-	-	-	1
80	<i>Ulothrix subconstricta</i>	Ulvophyceae	Ulotrichales	Ulotrichaceae	-	-	-	+	-	1
81	<i>Ulothrix variabilis</i>	Ulvophyceae	Ulotrichales	Ulotrichaceae	-	-	+	-	-	1
82	<i>Ulothrix zonata</i>	Ulvophyceae	Ulotrichales	Ulotrichaceae	+	-	-	+	-	2
83	<i>Cladophora glomerata</i>	Ulvophyceae	Cladophorales	Cladophoraceae	+	-	-	-	+	2

84	<i>Cladophora oligoclona</i>	Ulvophyceae	Cladophorales	Cladophoraceae	-	+	-	-	-	1
85	<i>Rhizoclonium hieroglyphicum</i>	Ulvophyceae	Cladophorales	Cladophoraceae	-	-	+	+	-	2
86	<i>Rhizoclonium tortuosum</i>	Ulvophyceae	Cladophorales	Cladophoraceae	-	-	-	-	+	1
87	<i>Rhizoclonium ramosum</i>	Ulvophyceae	Cladophorales	Cladophoraceae	-	-	+	-	-	1
88	<i>Rhizoclonium riparium</i>	Ulvophyceae	Cladophorales	Cladophoraceae	-	-	-	+	+	2
89	<i>Spirogyra eliptica</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	+	-	-	-	-	1
90	<i>Spirogyra gracilis</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	+	-	-	-	+	2
91	<i>Spirogyra decimina</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	+	-	+	-	-	2
92	<i>Spirogyra iyengari</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	+	-	-	+	2
93	<i>Spirogyra fluviatilis</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	-	-	+	-	1
94	<i>Spirogyra varians</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	-	+	-	-	1
95	<i>Spirogyra pratensis</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	+	-	-	+	-	2
96	<i>Spirogyra dentireticulata</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	-	-	+	-	1
97	<i>Spirogyra mirabilis</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	-	+	-	+	2
98	<i>Spirogyra punctate</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	+	-	-	+	2
99	<i>Spirogyra longata</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	-	+	-	+	2
100	<i>Spirogyra semiornata</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	-	+	-	-	1
101	<i>Spirogyra chenii</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	-	-	+	-	1
102	<i>Spirogyra minuticrassoidea</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	-	+	-	-	1
103	<i>Spirogyra pseudomaxima</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	-	-	-	+	1
104	<i>Spirogyra chungkingensis</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	+	-	+	+	3
105	<i>Mougeotia sp.</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	+	-	-	-	-	1
106	<i>Mougeotia elegantula</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	+	-	+	-	2
107	<i>Mougeotia varians</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	-	-	+	-	1
108	<i>Mougeotia tumidula</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	-	+	-	+	2
109	<i>Cosmarium depressum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	+	-	+	-	2
110	<i>Cosmarium renifarme</i>	Zygnematophyceae	Desmiales	Desmidiaceae	+	-	-	-	+	2
111	<i>Cosmarium angulosum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	+	-	+	+	-	3
112	<i>Cosmarium angulosum var. concinnum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	-	-	+	1
113	<i>Cosmarium divergens</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	+	+	-	-	2
114	<i>Cosmarium pseudoretusum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	-	-	+	1
115	<i>Cosmarium moniliforme</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	+	+	-	2
116	<i>Cosmarium formosulum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	+	-	-	-	+	2
117	<i>Pleurotaenium maculatum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	+	+	-	-	2
118	<i>Pleurotaenium ovatum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	-	-	+	1
119	<i>Pleurotaenium trabecular</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	-	+	-	1
120	<i>Closterium leibleinii</i>	Zygnematophyceae	Desmiales	Closteriaceae	+	-	-	-	-	1
121	<i>Closterium venus</i>	Zygnematophyceae	Desmiales	Closteriaceae	-	-	+	+	-	2
122	<i>Closterium littorale</i>	Zygnematophyceae	Desmiales	Closteriaceae	-	+	-	-	-	1
123	<i>Closterium cf. praelongum</i> <i>Var. brevis</i>	Zygnematophyceae	Desmiales	Closteriaceae	-	-	+	-	-	1
124	<i>Closterium pritchardianum</i>	Zygnematophyceae	Desmiales	Closteriaceae	-	-	-	+	+	2
125	<i>Closterium lunula</i>	Zygnematophyceae	Desmiales	Closteriaceae	+	-	+	-	-	2
126	<i>Euastrum ceylanicum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	+	-	-	-	+	2
127	<i>Euastrum ansatum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	+	-	-	-	-	1
128	<i>Desmidium elegans</i>	Zygnematophyceae	Desmiales	Desmidiaceae	+	-	+	-	-	2
129	<i>Desmidium baileyi</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	-	+	-	1
130	<i>Penium spinospermum</i>	Zygnematophyceae	Desmiales	Peniaceae	-	-	-	-	+	1
131	<i>Actinotaenium diplosporum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	+	+	-	2
132	<i>Xanthidium sexmammillatum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	-	-	+	1
133	<i>Zygnema terrestre</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	+	+	-	-	-	2
134	<i>Zygnema cylindricum</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	+	-	-	+	-	2
135	<i>Zygnema ovoidanum</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	+	-	-	+	-	2
136	<i>Zygnema cruciatum</i>	Zygnematophyceae	Zygnematales	Zygnemataceae	-	-	+	-	-	1
137	<i>Cylindrocystis sp.</i>	Zygnematophyceae	Zygnematales	Mesotaeniaceae	-	-	+	+	-	2
138	<i>Micrasteria brachyptera</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	-	-	+	1
139	<i>Hyalotheca mucosa</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	-	+	+	2
140	<i>Staurastrum pinnatum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	+	-	+	2
141	<i>Staurastrum bieneanum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	+	+	-	-	2
142	<i>Staurastrum convolutum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	+	-	-	+	-	2
143	<i>Staurastrum recurvatum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	-	+	-	1
144	<i>Staurastrum saltans</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	+	-	+	2
145	<i>Staurastrum gracile</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	-	-	+	1
146	<i>Staurastrum paradoxum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	-	-	+	1
147	<i>Staurastrum tetracerum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	-	-	-	-	+	1
148	<i>Staurastrum sonthalianum</i>	Zygnematophyceae	Desmiales	Desmidiaceae	+	-	-	+	-	2
149	<i>Gonatozygon monotaenium</i>	Zygnematophyceae	Desmiales	Gonatozygaceae	-	-	+	+	-	2
150	<i>Coleochaete pulvinata</i>	Coleochaetophyceae	Coleochaetales	Coleochaetaceae	-	-	+	-	-	1
151	<i>Glaucocystis major</i> <i>reproductive stage</i>	Glaucophyceae	Glaucocystales	Glaucocystaceae	-	-	-	-	+	1
152	<i>Nitella sp.</i>	Charophyceae	Charales	Characeae	-	+	+	-	-	2
153	<i>Asterococcus sp.</i>	Mamiellophyceae	Mamiellales	Bathycoccaceae	-	-	+	-	+	2
154	<i>Elakatothrix gelatinosa</i>	Klebsormidiophyceae	Klebsormidiales	Elakatotrichaceae	-	-	-	+	+	2
155	<i>Dictyosphaerium simplex</i>	Trebouxiophyceae	Chlorellales	Chlorellaceae	+	+	-	-	-	2
156	<i>Dictyosphaerium chlorelloids</i>	Trebouxiophyceae	Chlorellales	Chlorellaceae	+	-	+	-	-	2
157	<i>Trebouxia sp.</i>	Trebouxiophyceae	Trebouxiales	Trebouxiaceae	+	-	-	-	+	2
158	<i>Chlorella vulgaris</i>	Trebouxiophyceae	Chlorellales	Chlorellaceae	+	-	-	-	-	1
159	<i>Chlorella peruviana</i>	Trebouxiophyceae	Chlorellales	Chlorellaceae	+	+	-	-	-	1
160	<i>Chlorella ovalis</i>	Trebouxiophyceae	Chlorellales	Chlorellaceae	-	-	+	+	-	2
161	<i>Chlorella luteoviridis</i>	Trebouxiophyceae	Chlorellales	Chlorellaceae	-	-	-	-	+	1
162	<i>Botryococcus braunii</i>	Trebouxiophyceae	Trebouxiales	Botryococcaceae	-	-	-	+	-	1

163	<i>Micractinum</i> sp.	Trebouxiophyceae	Chlorellales	Chlorellaceae	-	-	+	-	+	2
164	<i>Amphikrikos minutissimus</i>	Trebouxiophyceae	Chlorellales	Oocytaceae	-	+	-	+	-	2

The species diversity of a Chlorophyceae member was maximum during the period of study; the results were observed in (Fig 1). *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, *Oedogonium* gracileus, *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*, *Spirogyra* *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 included.

For chlorophyta [10], [12-18], [20-22], [27-31] manuals were studied. Several *Ulothrix* species have been found in streams and waterfalls in India's Eastern and North-Eastern regions, according to [4].

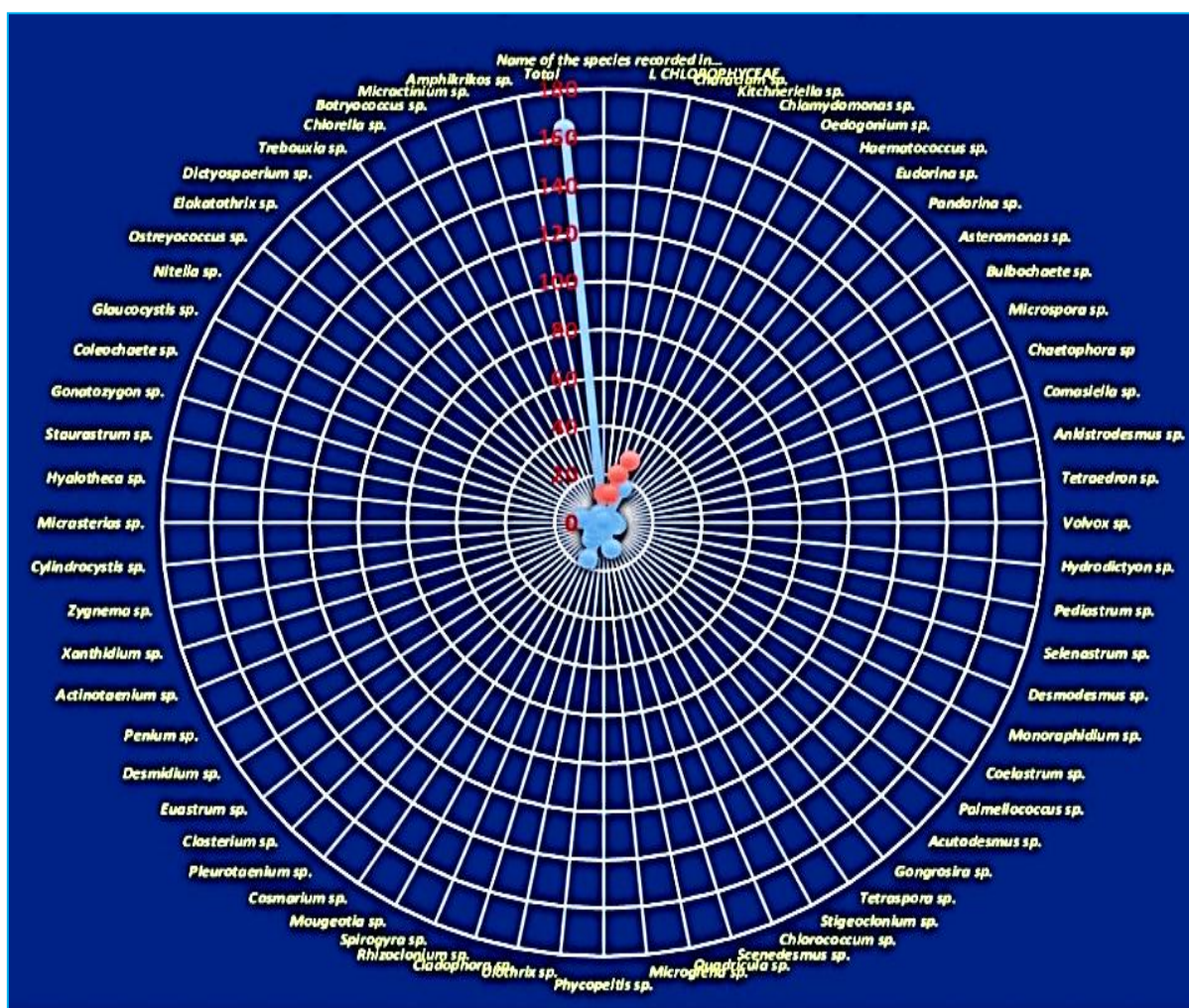


Fig 1 List of species recorded in Chlorophyceae

CONCLUSION

The present study, for the identification of algae, dichotomous keys were used (Bracketed key). Totally 164 taxa of chlorophyceae belonging to 61 genera and 32 families were recorded. More species belonged to the *Oedogonium* sp., *Spirogyra* sp. *Scenedesmus* sp. and *Desmids*. The present

findings conclude as follows, waterfalls are the best suitable ecosystem for micro algal growth and diversity.

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