

TAXONOMIC STUDY OF GREEN ALGAE OF LOWER RIVER SWAT KPK, PAKISTAN

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Abstract

This research work is based on the taxonomic study of Chlorophycota. A total of 24 species were collected belonging to 10 genera and 8 families. As a whole the taxa collected from this area were *Spirogyra* (9 species), *Rhizoclonium* (3 spp.), *Ulothrix* (3 spp.), *Cladophora* (2 spp.), *Oedogonium* (2 spp.), while each of *Chlorochytrium*, *Zygnema*, *Vaucheria*, *Basycladia* and *Chara* had only one species.

Introduction

Swat and Malakand lie between 34.22⁰ to 34.55⁰ North latitude and 71.37⁰ to 72.50⁰ East longitudes. Swat is bounded on the North by Chatral and ghizer district, on the East by Kohistan and Shangla, on the south by Distt: Buner and Malakand agency, on the West by lower and upper Dir (District, 1998). Many workers reported different species of algae from different areas of Pakistan, like several studies have been made in the past on the taxonomy of freshwater green algae from north-eastern areas of Pakistan (Randhawa, 1936; Masud-ul-Hasan, 1978a, b, 1980; Shahida *et al.*, 2005; Zarina *et al.* 2005, 2006, 2007), but only a few investigations were carried out in this connection on microalgae (Masud-ul-Hasan & Zeb-un-Nisa, 1986; Masud-ul-Hasan & Batool 1987, Masud-ul-Hasan & Yunus, 1989; Masud-ul-Hasan *et al.*, 1995; Sarim, 1995; Husna *et al.*, 2006; Shahida *et al.*, 2006). Zaman *et al.*, (2009), recorded seventeen species of *Spirogyra*, from Peshawar valley. Ara & Faridi, (1978), reported various species of *Spirogyra* from Peshawar valley and Pakistan, respectively. Asghar *et al.*, (2010), studied Forty-two species of the genus *Spirogyra* from various freshwater habitats of Gujranwala, Jhang, Kasur, Lahore, Sheikhpura and Sialkot and Attock Districts of the Punjab Province and Swat of KPK. Shameel (2001) presented an approach for the classification of algae in the new millennium. With this idea in mind, a large survey was carried out to collect green algae from various freshwater habitats of lower River Swat. The present research is the first report in this connection on Chlorophycota from the selected area.

Materials and Methods

Present research work was carried out on five selected spots of River Swat namely Amandara, Chakdara, Thana, Landakey and Barikot. The samples from these areas were collected during March, April and May 2007. Each sample was numbered and all other information was recorded on the spots. Water samples were also collected from the spots and brought to the laboratory for further investigation, however results are not presented in this paper. Knife and sticks were used as tools for collection purpose. All the collected algal samples were preserved in 3 % formalin in the Department of Botany, Islamia College, Peshawar and Shaheed BB University Sheringal. Microscopes and other literature books were used for the identification of collected samples (Børgesen, 1901; West, 1904; Krieger, 1950; Wasylik, 1961; Hirano, 1964; Biswas, 1975; Duthie & Ostrofsky, 1975; Wehr & Sheath, 2003; John *et al.*, 2005).

Results and Discussions

A total of 24 species belonging to eight families and 10 genera were collected for the first time from the study area. Details of these species are given in Table 1.

Key to the collected genera

1. Microscopic, having rhizoidal erect stem like branches and whorl of secondary branches or leaves, vary in height from 2-10 cm-----*Chara*
Otherwise-----2
2. Chloroplast one to several, large in the form of spiral bands with stellate masses or broad plates, pyranoids conspicuous, reproduction by conjugation-----3
Other wise-----4
3. Chloroplasts 2, axial, star-shaped or pad-like bodies in each cell, conjugating cells not becoming filled with pectic substances-----*Zygnema*

- Cells with parietal ribbon or spiral chloroplast, with several to many pyrenoids in a single series-----
-----*Spirogyra*
4. Filaments composed of cylindrical, coenocytic cells which become attenuated towards their apices, setae and bristles wanting-----5
Otherwise-----6
 5. Filaments branched-----7
Filaments not branched-----*Rhizoclonium*
 6. Filaments repeatedly branched-----*Cladophora*
Filaments branched from the base-----*Basycladia*
 7. Filaments branched, attached or free floating-----*Ulothrix*
Otherwise-----8
 8. Filaments composed of cells which are larger at the anterior end, bearing setae with much enlarge, bulbous bases; reproduction oogamous, the female gametes produced in conspicuously swollen gametangia-----*Oedogonium*
Otherwise-----9
 9. Thalli composed of long, branched , coenocytic strands-----*Vaucheria*
Thalli composed of a colony of definite or indefinite form, cells various in shape-----*Chlorochytrium*

Table 1. Check-list of green algae collected from the lower parts of River Swat.

No	Family	Genus	S/No	Species	Locality
1	Characeae	<i>Chara</i>	1.	<i>C. schweinitzii</i> A. Braun	Landakey
2	Cladophoraceae	<i>Cladophora</i>	2.	<i>C. crispata</i> (Roth) Kützing	Chakdara
			3.	<i>C. glomerata</i> (L.) Kützing	Thana
3	Endosphaeraceae	<i>Chlorochytrium</i>	4.	<i>Ch. lemnae</i> Cohn	Chakdara
4	Oedogoniaceae	<i>Oedogonium</i>	5.	<i>O. angustissimum</i> West et West	Thana
			6.	<i>O. anomalium</i> (Hirn)	Thana
5	Cladophoraceae	<i>Rhizoclonium</i>	7.	<i>R. crasspetitium</i> West et West	Chakdara
			8.	<i>R. fontanium</i> Kützing	Thana
		<i>Basycladia</i>	9.	<i>R. Hookeri</i> Kützing	Landakey
			10.	<i>B. crassa</i> Hoffman et Tilden	Chakdara
6	Zygnemaceae	<i>Spirogyra</i>	11.	<i>S. borysthenica</i> Kasanowsky et Smirnof	Thana
			12.	<i>S. sulcata</i> Blum	Chakdara
			13.	<i>S. communis</i> (Hassal) Kützing.	Thana
			14.	<i>S. ellipsozona</i> Transeau	Thana
			15.	<i>S. nitida</i> (Dillwine) Link	Amandara,
			16.	<i>S. fuellebonei</i> Schmidle	Chakdara
			17.	<i>S. rivularis</i> (Hassal) Rabenhorst	Landakey
			18.	<i>S. aequinoctialis</i> G. S. West	Thana
			19.	<i>S. orientalis</i> West et West	Amandara
		<i>Zygnema</i>	20.	<i>Z. decussatum</i>	Chakdara
7	Ulotrichaceae	<i>Ulothrix</i>	21.	<i>U. subconstricta</i> West	Amandara
			22.	<i>U. tenuissima</i> Kützing	Chakdara
			23.	<i>U. zonata</i> (Weber et Mohr) Kützing	Chakdara Thana,
8	Vaucheriaceae	<i>Vaucheria</i>	24.	<i>V. nicholsi</i> Brown	Chakdara

***Basycladia* Hoffman et Tilden, 1930 (Prescott 1970: 144)**

Thallus body erect, filamentous and attached with prostrate, rhizoidal portions serving as anchoring organs, giving support to the erect filaments, branched near the base. Basal cells cylindrical, very long, becoming shorter and wider above. Cell walls thick and lamellate. Chloroplast dense, parietal reticulum. Sexual reproduction by isogametes produced in common cells in the distal region of the filament. Asexual reproduction by zoospores is also possible. There was a single species in the research area *Basycladia crassa*.

***Basycladia crassa* Hoffman et Tilden, 1930 (Prescott 1970: 144) Plate: 1 (5)**

Thallus composed of prostrate and upright filaments as much as 2.4 cm. in length with rigid upright branching, 55- 120 µm in diameter in the distal portions, composed of thick-walled coenocytic units up to 3150 µm in

length, the vertical filaments dichotomously branched sometimes to the second order, but straight and rigid, gradually tapering toward the anterior end.

Chara Linnaeus, 1754 (Prescott 1970: 334)

The thalli are stout in course of texture when compared with *Nitella*. Frequently encrusted with lime and thrive best in hard and semi hard water lakes and slowly flowing streams. Stem in most species is corticated by elements which develop from the node cells in both directions along the internodal cells and so meet cortical cells from the node above and below. Both monoecious and dioecious species are included in this genus, only a single species was there in the collection.

Chara schweinitzii (Prescott 1970: 340) Plate 3 (1, 2)

Thallus is bright green, not at all encrusted with lime, 10-15 cm high, stem long jointed with a single whorl of stipulodes at the node, which also gives rise 8-11 leaves, internodes of both stem and leaves are corticated; sex organs monoecious, usually borne on the same node; oogonia 0.8-0.9 cm long subtended by bracts, which are equal in length to the mature fruit or as much as 3 time longer; cortical cell of oogonia showing 7-9 turns, antheridia 0.2- 0.3 mm in diameter.

Cladophora Kützing, 1843 (Prescott 1970: 135)

A repeatedly-branched filamentous thallus with basal-distal differentiation; attached when young but in some species becoming free-floating; forming feathery tufts on substrates, especially in flowing water; branching alternate, opposite, or sometimes di- or trichotomous, the branches smaller than the main axis, or at least tapering slightly toward the apices; cells cylindrical or swollen; walls thick and lamellate in most species, sometimes thin and firm; chloroplast a parietal reticulum which sometimes becomes fragmented and appears as numerous discs; pyrenoids present; asexual reproduction by zoospores; sexual reproduction by isogametes produced in apical or sub apical, unspecialized cells. Two species the *Cladophora crispata* and *Cladophora glomerata* (L) were found in the collection.

Key to the species: Thallus attached permanently in flowing water, Branching increasing toward the upper portions of the frond to form dense terminal tufts ----- *C. glomerata* Thallus free-floating, at least when mature; branches frequent, repeatedly branched, the branches long and tapering -----
-----*C. crispata*

Chlorochytrium Cohn, 1875 (Prescott 1970: 214)

Unicellular, oblong ellipsoidal, often irregular in outline, formed when a zygote germinates and sends a tubular elongation into the tissues of *Lemna*, the cell contents migrating into the tube and then enlarging among the host cells, the entrance tube persisting as a knob-like extension of the wall, which is thick and lamellate; chloroplast at first parietal, later becoming radial and massive; reproduction by division of the cell contents into a large number of biflagellate isogametes or zoospores. The collection includes the following species.

Chlorochytrium lemnae Cohn, 1875 (Prescott 1970: 214)

Cells broadly ellipsoidal or ovate, with 1 or more knob like extensions; wall thick and lamellate; cells 60- 100 μ m in diameter, inhabiting the tissues of *Lemna trisulca*. In host plants collected from water of marshy lakes; in roadside swamps.

Oedogonium Link, 1820 (Prescott 1970: 156), Plate 2(3)

Filamentous having one cell thickness. Reproduces by two ways sexually and asexually. Sexually by syngamy in which the antheridia produce sperm and the oogonia produce egg, the two get fuse to form zygote (2n). The zygote then produces the filamentous green alga which is haploid (1n). The *Oedogonium* can also reproduce asexually through zoospores. These separate from the parent thalli through the zoosporangium and continue to divide producing the filamentous green individuals. *Oedogonium* is usually free floating when mature though it can be attached to plants. It is found in quiet freshwater. It has a spiral shape with a greenish tinge to it. Two species were found on the bank of river.

Key to the species: Monoecious vegetative cells 1.8-2 μ m in diameter----- *O. angustissimum*

Dioecious, oospores globose to ovoid, 48-60 μ m in diameter; oogonia sub ovoid-----
----- *O. anomalium*

Rhizoclonium Kützing, 1843 (Prescott 1970: 141), Plate 1 (4)

Filamentous, coarse and wiry forming tangled floating mat or caught about submerged aquatics, either unbranched or with short multicellular branching but without basal distinct differentiation in the plane of

branching, cells stout, either short or cylindrical, rarely with inflated lateral walls which in most species are thick and lamellate and often completely evergreen with epiphytic diatoms and blue green algae. Chloroplast a parietal reticulum, often dense and difficult of interpretation sometime loose and appearing as if composed of many irregularly shaped ovate chloroplast each with pyrenoids. There were only three species in the collection.

Key to the species

1. Filaments frequently branched, usually very irregular, many celled-----
-----*R. crasspetitium*
Filaments seldom branched or if so one celled-----2
2. Filaments upto 22 µm in diameter, branches simple-----*R. fontanum*
Filaments more than 60 µm in diameter, branches of a second order frequently present-----
-----*R. hookeri*

Spirogyra Link, 1820 (Prescott 1970: 307, Plate 1(1, 2, 3), 3(3, 4))

Filaments long unbranched, usually without basal distal differentiation but sometime with rhizoidal branches developing laterally where the filament comes in contact with substrate. Cells cylindrical short to very long in some species, with plane, replicate or colligate (exterior H shaped piece) end walls. Chloroplast a parietal band or ribbon shaped, which may be spirally twisted 1/2 to 3 rarely (8) turns or may be nearly straight. Conjugation either lateral or scalariform, usually by the formation of tubes.

Key to the Species of *Spirogyra*

1. End wall of cells plane-----2
End wall of cells replicate-----*S. borysthenica*
2. Chloroplast 1 rarely 2 in each cell-----3
Chloroplasts 2-16 in each cell-----4
3. Spore ovate, 43-46 µm in diameter-----*S. sulcata*
Spore ellipsoid-----*S. communis*
4. Median spore wall smooth-----5
Median spore wall not smooth-----8
5. Vegetative cells 125-250 µm in diameter-----*S. ellisospora*
Vegetative cells smaller than 125 µm in diameter-----6
6. Vegetative cells more than 45 µm in diameter-----*S. nitida*
Vegetative cells less than 45 µm in diameter-----7
7. Vegetative cells 40-44 µm in diameter, up to 240 µm long, chloroplasts 3, making 1-2 turns, spore 32-40 µm in diameter-----*S. fuellebonei*
Vegetative cells averaging smaller, 36-41 µm in diameter, up to 400 µm long, chloroplasts 2-3, making 2 1/2 -3 1/2 turns-----*S. rivularis*
8. Spore ellipsoid-----*S. orientalis*
Spore ovate-----*S. aequinocitialis*

Zygnema C. A. Agardh, 1824 (Prescott 1970: 323)

Thallus is filamentous, unbranched of either short or long cylindrical cells with plane end walls, enclosed by a soft (usually) mucilaginous sheath, chloroplasts 2-4 axial, each containing a large central pyrenoid with a conspicuous starch sheath. Conjugation mostly scalariform. Asexual reproduction by aplanospores and akinetes. The collection included the following species.

Zygnema decussatum (Vauch) Transeau, 1914 (Prescott 1970: 325)

Vegetative cells 18-20 µm in diameter and up to 100 µm long, the wall without a thick layer of mucilage; fertile cells not inflated. Zygosporangia formed in the tube; globose or depressed-globose; median spore wall brown and scrobiculate; 27-30 µm in diameter.

Ulothrix Kützing, 1833 (Prescott 1970: 95)

Simple, unbranched, filamentous arising from a basal holdfast cell; becoming free floating in some species, Chloroplast a parietal band which extends 2/3 to 3/4 of the way around the cell (forming a complete ring in one species) and sometime extending the entire length of the cell. Asexual reproduction by 4-8 quadriflagellate zoospores cut from the protoplast of unspecialized cells, sexual reproduction by isogametes which form 8-16-64 number of cells smaller than the zoospores and biflagellate palmella stage not uncommon. Key to the species as follows

1. Cells shorter than wide up to 20 µm in diameter-----*U. tenuissima*
Cells longer than wide cylindrical-----2
2. Filaments (20)-25-45-(60) µm in diameter; wall thick; chloroplast a complete parietal band-----
-----*U. zonata*
3. Filaments constricted at the cross walls, 5.7-9.0 µm in diameter; cells 2-4 times long-----
-----*U. subconstricta*

Vaucheria De Candolle, 1805 (Prescott 1970: 290)

Thallus sub aerial or aquatic, a much and irregularly branched siphonous coenocyte without cross-walls except where reproductive structures are cut off; filaments often compactly interwoven (especially in terrestrial species) to form a felt-like expansion, with colourless rhizoids when attached, or forming entangled clots of coarse threads when floating; branches arising laterally or dichotomously, nearly as large as the main filament and tapering slightly to broadly rounded tips; chloroplasts numerous ovate discs without pyrenoids. Both sexual and asexual reproduction is present. A single species was collected from the spot.

Vaucheria nichosii Brown, 1937 (Prescott 1970: 291-3), Plate 2(4, 5)

Filaments very coarse, 112-120 µm in diameter; monoecious; oogonium globose, sessile, the opening vertical, 262-289 µm in diameter; oospore of the same shape as and filling the oogonium (except the beak), yellow-brown; antheridia sessile, arising from all sides of the main filament near the oogonium and recurved so as to lie parallel with the filament and opening toward the oogonium, 39-50µm wide, 115-123 µm long

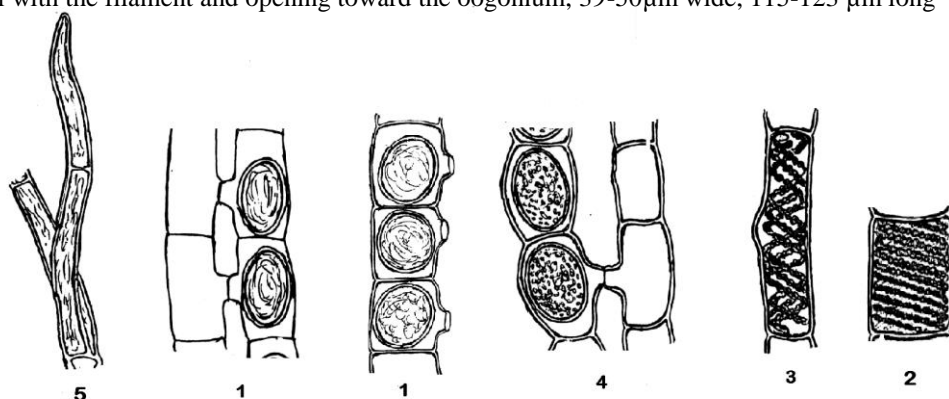


Plate 1. 1. *Spirogyra*, 2. *Spirogyra crassa*, 3. *Spirogyra equinoctialis*, 4. *Rhizoclonium fontanum*, 5. *Basicladia crassa*.

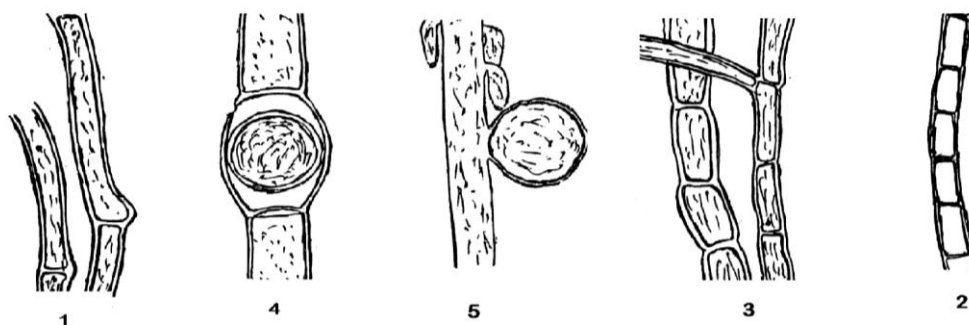


Plate 2. 1. *Basicladia crassa*, 2. *Rhizoclonium hookeri*, 3. *Oedogonium anamalium*, 4.&5. *Vaucheria nichosii*

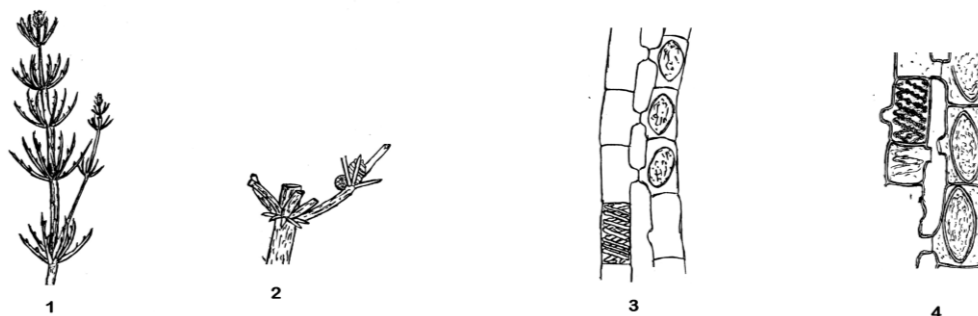


Plate 3. 1. *Chara schweinitzii*, 2. *Chara schweinitzii*, 3. *Spirogyra fuelbornei*, 4. *Spirogyra ellipospora*.

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