

## TAXONOMIC STUDY OF THE CLASS SIPHONOCLADOPHYCEAE SHAMEEL FROM NORTH-EASTERN AREAS OF PAKISTAN

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### Abstract

Eight species of the coenocytic green algae belonging to the genera *Cladophora*, *Pithophora*, *Rhizoclonium* and *Sphaeroplea* were collected from various freshwater habitats in Kasur, Lahore, Sheikhupura and Sialkot districts of the Punjab, Attock (NWFP) and Neelum Valley of Azad Kashmir during January 2004 - April 2005. They were taxonomically determined and found to belong to the orders Cladophorales and Sphaeropleales. They have been described for the first time from these areas.

### Introduction

After the sad demise of Prof. M. A. F. Faridi and the retirement of Prof. Masud-ul-Hasan no study was conducted on the algal flora of the north-eastern areas of Pakistan, therefore, the present research program was made. As a result of that, starting from December 2003 a large collection of grass green, yellow green and stonewort algae was made from freshwater habitats of various districts of the Punjab, certain areas of NWFP and Azad Kashmir. They were taxonomically determined and systematically described (Zarina *et al.*, 2005a, b). This is a continuation of that research program. Several *Bryopsis* species were found to produce stephanokontic zoospores and to serve as gametophyte of a *Derbesia* (Rietema, 1969, 1970, 1971a, b), therefore, it appeared more plausible to place *Bryopsis* in the Derbesiaceae instead of its own family Bryopsidaceae. As a result of that all higher typified taxa lost their existence. Therefore, the name Bryopsidophyceae has been replaced by a new name Siphonocladophyceae by Shameel (2001). Eight species belonging to this class have been investigated and described here.

### Materials and Methods

The specimens were collected from various freshwater habitats in Kasur, Lahore, Sheikhupura and Sialkot districts of the Punjab and Attock in NWFP provinces of Pakistan as well as from Azad Kashmir during January 2004 - April 2005. They were taxonomically investigated as described earlier (Zarina *et al.*, 2005a). The collected material was identified with the help of authentic literature (West, 1904; Prescott, 1962; Faridi, 1971; Pankow, 1971; Nizamuddin & Begum 1973; Nizamuddin & Gerloff, 1982, Kornmann & Sahling, 1983; Womersley, 1984; Masud-ul-Hasan & Batool 1987). The voucher specimens are kept in the Phycology & Phycochemistry Lab., M. A. H. Qadri Biological Research Centre, University of Karachi, where this research work was conducted.

## Results and Discussion

Eight species of the coenocytic green algae belonging to the phylum Chlorophyta, Class Siphonocladophyceae, orders Cladophorales and Sphaeropleales have been identified (*fide* Shameel, 2001). Their taxonomic enumerations are given below:

### Class Siphonocladophyceae Shameel 2001: 242

Green macroalgae, thallus coenocytic, siphonaceous, filamentous or thalloid.

#### Order Cladophorales

Multinucleate forms with thick walled cylindrical cells, united end to end in simple or branched filaments. The chloroplast is a parietal, net like or fragmented or reticulate sheet, encircling the protoplast and with a pyrenoid at many intersections of the reticulum. Filaments coarse and wiry, mostly unattached and branched. Branching, when occurs is irregular, no arbuscular plane of growth. Some species with short rhizoidal branches. Reproductive organs open by fissures or simple pores. Asexual reproduction is by means of quadriflagellate zoospores and aplanospores, sexual reproduction is iso- and aniso-gamous. Following genera were collected which may be distinguished as follows:

1. Filaments with akinetes .....	<i>Pithophora</i>
Filaments without akinetes .....	2
2. Branches smaller .....	<i>Rhizoclonium</i>
Branches larger .....	<i>Cladophora</i>

#### *Cladophora* Kützing 1843: 262, *nom. cons.*

Large, sometimes coarse tufts of branching filaments, composed of long and multinucleate cells. The chloroplast is characteristically a reticulate cylinder, sometimes dissociated to form a network of small, discoid chloroplasts. All thalli begin as attached, but only some remain permanently so. Following two species were collected which may be distinguished as follows:

1. Filaments trichotomously branched .....	<i>C. aegagropila</i> (1)
Filaments dichotomously branched .....	<i>C. crispata</i> (2)

##### 1. *C. aegagropila* (Linnaeus) Rabenhorst 1868: 343

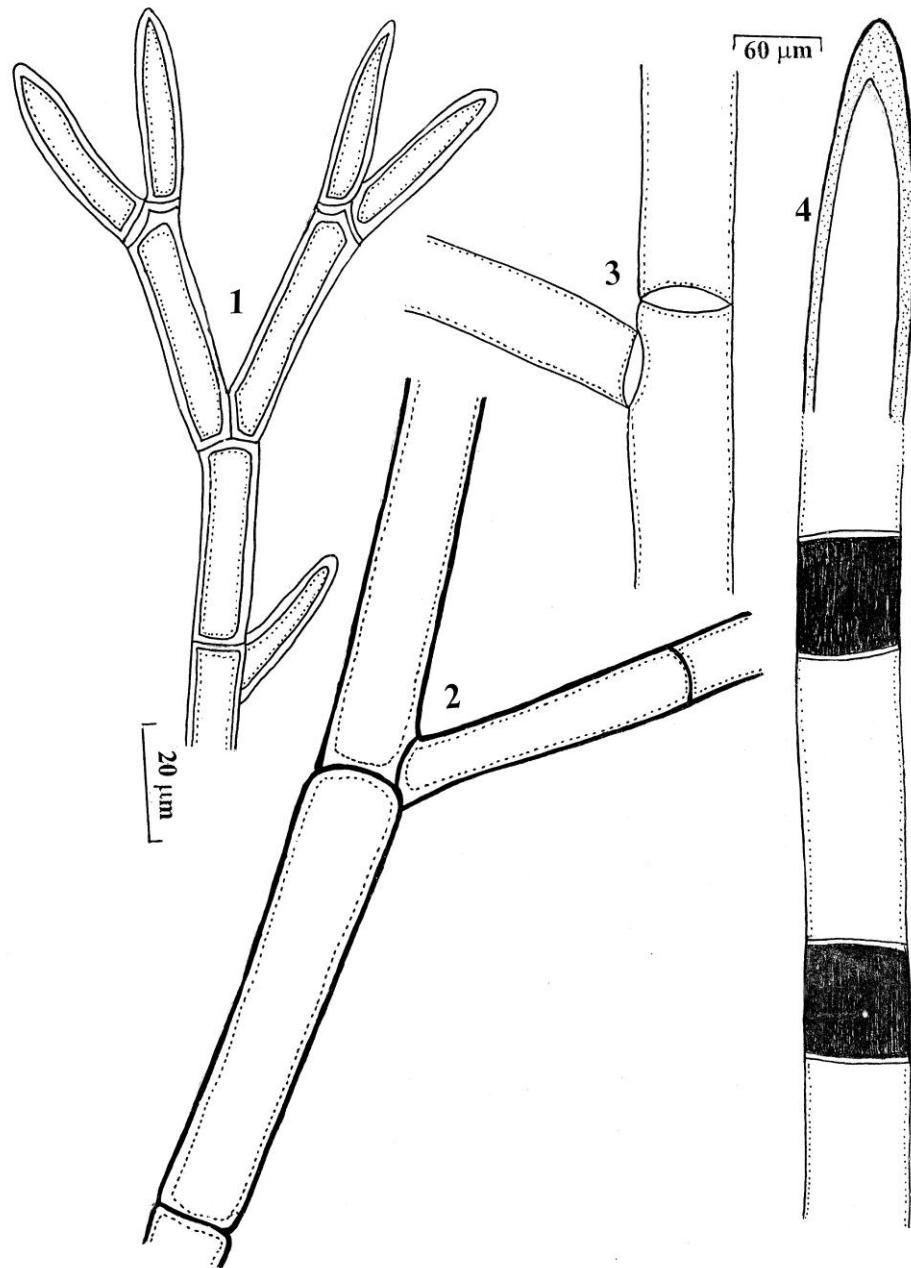
(Pankow, 1971: 113; Nizamuddin & Gerloff, 1982: 132; Womersley, 1984: 190)

**Basionym:** *Conferva aegagropila* Linnaeus 1753.

**Morphological characters:** Thalli considerably branched and bushy in form; ultimate branches not differing greatly in size from the main ones; branching appear to be trichotomous by avescion (Fig. 1).

**Cytological features:** Cells of any branch may be swollen at the apex; cell width usually 45-90  $\mu$ m.

**Reproductive structures:** Reproductive organs were not observed.



Figs. 1-4. Species of the Cladophorales: 1. *Cladophora aegagropila*, 2. *C. crispata*, 3. *Pithophora cleveana*: vegetative filament with branching, 4. *P. cleveana*: filament with akinetes.

**Localities:** Lahore District: Mahmood Booti (2-7-2004); Sheikhupura District: paddy fields near Mureedke and Narang Mundi (20-9-2004); Azad Kashmir: Neelum Valley (20-3-2004, 5-4-2005).

**Type locality:** Lakes in Sweden.

**Geographical distribution:** Sweden, Libya, China, Srilanka, Australia.

**Remarks:** The collections were carried out from three different areas during spring and summer. In Lahore it was obtained in summer season. The pH of water in the rice fields of Sheikhupura, wherefrom algae were collected, was slightly alkaline (8.0). In Azad Kashmir it was obtained during the months of March and April from stagnant water ponds. Slight cytological differences (specially in cell width) were observed among specimens collected from different habitats.

## 2. *C. crispata* (Roth) Kützing 1843: 264

(West, 1904: 105; Prescott, 1962: 137)

**Basionym:** *Conferva crispata* Roth 1797.

**Morphological characters:** Branches diverging conspicuously at wide angles, giving the impression of dichotomy, no glomerate fascicles formed (Fig. 2).

**Cytological features:** Cells generally cylindrical, width 49-51  $\mu\text{m}$  or more.

**Reproductive structures:** In the present collection reproductive organs were not observed.

**Locality:** Azad Kashmir: Neelum Valley (20-3-2004).

**Geographical distribution:** U.S.A., U. K., India.

**Remarks:** It occurred in slow running water of streams throughout the area of collection. During this study it was found only in vegetative form and not in reproductive phase.

## *Pithophora* Wittrock 1877: 48

The side branches are almost at right angle to the main filament. There seems to be a tendency for the first cross wall in a branch to form at some distance above its junction. The main character is the presence of conspicuous akinetes, which occupy various cells, sometimes alternating with vegetative cells. Following two species were collected which may be distinguished as follows:

1. Akinetes rectangular, up to 125  $\mu\text{m}$  broad ..... *P. cleveana* (3)
- Akinetes polymorphic, more than 125  $\mu\text{m}$  broad ..... *P. oedogonia* (4)

### 3. *P. cleveana* Wittrock

**Morphological characters:** Branches emerging below septum of main filament (Fig. 3).

**Cytological features:** Cells 5-6 times longer than broad.

**Reproductive structures:** Akinetes intercalary, 120-125  $\mu\text{m}$  broad, almost rectangular in shape (Fig. 4).

**Locality:** Lahore District: Mahmood Booti (2-7-2004).

**Geographical distribution:** U.S.A., Germany.

**Remarks:** The collection work was carried out in summer season from a village of the border area of Lahore. During this season border area shows rich growth of green algae as compared to other areas of Lahore, because it is totally a cultivated area of rice and other grain crops. Therefore, this alga was found in large quantity. The collected specimens were found in reproductive condition.

**4. *P. oedogonia* (Montagne) Wittrock 1877: 55**

(West, 1904: 107; Prescott, 1962: 137)

**Basionym:** *Conferva oedogonia* Montagne 1850.

**Morphological characters:** Filaments rarely branched and consistently cask-shaped; width of filaments 46-82  $\mu\text{m}$  and length 200-925  $\mu\text{m}$ ; three orders of branching (Figs. 5,6).

**Cytological features:** Vegetative cells 60  $\mu\text{m}$  broad and 600-630  $\mu\text{m}$  long (cells many times longer than broad); chloroplast reticulate, embedded with pyrenoids.

**Reproductive structures:** Akinetes intercalary, about 77-192  $\mu\text{m}$  broad and 162-300  $\mu\text{m}$  long, variously shaped: *e.g.*, spherical (Fig. 7), rectangular (Fig. 9), cylindrical (Fig. 8), barrel-shaped but never consistently hexagonal.

**Localities:** Kasur District: Al-Feroze Town (28-1-2004); Lahore District: Mahmood Booti (2-7-2005); Sheikhupura District: between Mureedke and Narang Mundi (12-9-2004); Sialkot District: near main G.T. Road (25-5-2004).

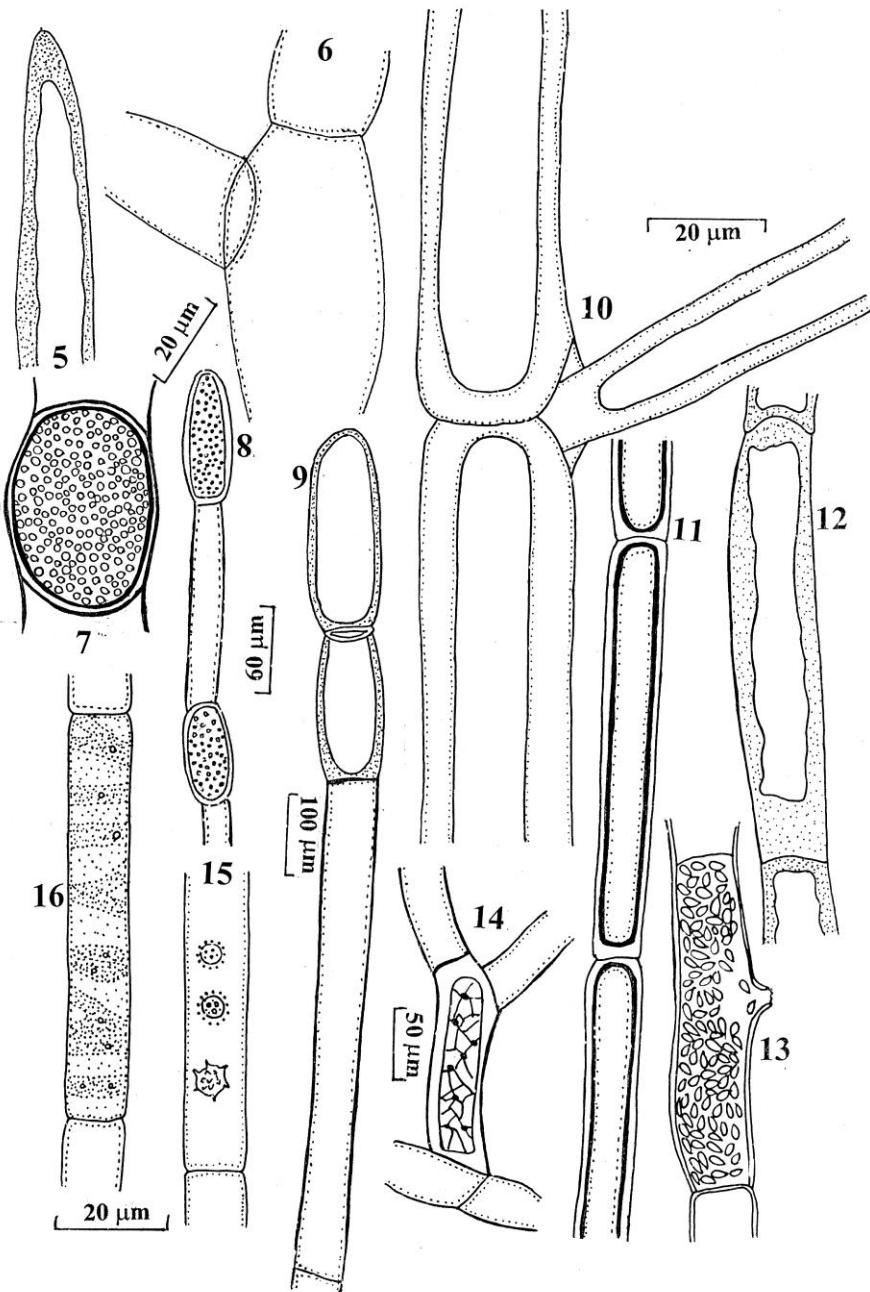
**Geographical distribution:** U.S.A., U. K., India (Forest, 1954).

**Remarks:** Specimens were collected from four different localities of the Punjab during different months of summer, winter and spring seasons. They were obtained from paddy fields in spring and other water sources during summer and winter. Morphological and reproductive variations were observed within specimens collected from different localities under various temperatures. It occurred in massive quantity in rice fields.

***Rhizoclonium* Kützing 1843: 261**

Filaments contain both branched and unbranched forms. The branching is almost at right angle and the first cross wall of the branches is formed away from the junction. However, a transition of branches may be observed through short unicellular side stump to multicellular branches of indefinite length. The uniseriate filaments possess occasional or numerous, short, septate or non-septate, colourless branches. The number of nuclei per cell ranges from 1-4. Chloroplast is a reticulate plate or a pattern of small chloroplasts. Asexual reproduction is by means of biflagellate zoospores which in some species also possess unequal flagella. Following three species have been collected which may be distinguished as follows:

1. Filaments unbranched .....	<i>R. hieroglyphicum</i> (6)
Filaments branched .....	2
2. Thallus mostly branched .....	<i>R. fontanum</i> (5)
Thallus rarely branched .....	<i>R. implexum</i> (7)



Figs. 5-16. Species of the Siphonocladophyceae: 5. *Pithphora oedogonia*: tip of a filament, 6. *P. oedogonia*: emergence of a branch, 7. *P. oedogonia*: spherical akinetes, 8. *P. oedogonia*: cylindrical akinetes, 9. *P. oedogonia*: filament with rectangular akinetes, 10. *Rhizoclonium fontanum*, 11. *R. hieroglyphicum*: part of a filament, 12. *R. hieroglyphicum*: a cell, 13. *R. hieroglyphicum*: zoospores, 14. *R. implexum*, 15. *Sphaeroplea annulina*: part of a cell, 16. *S. annulina*: a cell.

**5. *R. fontanum* Kützing 1843: 261**  
(Prescott, 1962: 142)

**Morphological characters:** Branched filaments with long cells; branches of one order arise in between the two adjoining cells at right angle to the parent filament; cross walls laid down at some distance from it (Fig.10).

**Cytological features:** Cells cylindrical but un even lateral walls.

**Reproductive structures:** In present collection reproductive structure were not observed.

**Locality:** Sialkot District: Sambaral (6-4-2004).

**Geographical distribution:** U.S.A.

**Remarks:** Collection was made from stagnant water ponds during the month of April, where it occurred in free floating state. Although, the pH of water, light intensity and temprature of this area were suitable for its growth, but it was found only in vegetative form.

**6. *R. hieroglyphicum* (C. A. Agardh) Kützing 1843: 206**  
(Børgesen, 1901: 254; West, 1904: 103; Prescott, 1962: 142; Pankow, 1971: 111;  
Faridi *et al.*, 1981: 156; Ghazala *et al.*, 2005: 74)

**Basionym:** *Conferva hieroglyphica* C. A. Agardh 1827.

**Morphological characters:** Unbranched long filaments with long cells, tips of the filament rounded (Fig. 11).

**Cytological features:** Vegetative cells 23-112  $\mu\text{m}$  broad and 102-663  $\mu\text{m}$  long; chloroplast reticulate or broken; pyrenoids many (Fig. 12).

**Reproductive structures:** Asexual reproduction by zoospores, 50-65  $\mu\text{m}$  broad and 150-275  $\mu\text{m}$  long (Fig. 13).

**Localities:** Kasur District: Hawailyan Village (22-12-2004); Sheikhupura District: near Rana Bhatti (2-4-2004); Sialkot Distict: Adamkay Village (25-5-2004).

**Type locality:** Cave near Carlsbad, Karlovy Vary, Czech Rep.

**Geographical distribution:** U.S.A.: N.F.K. (Forest, 1954), Mountain of Mississippi, Czech Rep., U. K., Baltic Sea, Pakistan.

**Remarks:** The collection was carried out in different months of 2004. It occurred in drainage and temporary pond water. The water was highly polluted in irrigation channels. In different localities it was found sometimes in low and sometimes in high quantity.

**7. *R. implexum* (Dillwyn) Kützing 1845: 206**  
(Feldmann, 1937: 213; Pankow, 1971: 110; Nizammuddin & Begum, 1973: 16;  
Kornman & Sahling, 1983: 47; Womersley, 1984: 167)

**Basionym:** *Conferva implexa* Dillwyn 1809 [1802-1809].

**Synonym:** *Rhizoclonium kochianum* Kützing 1845: 206.

**Morphological characters:** Rarely branching filaments with long cells (Fig. 14).

**Cytological features:** Cells 44-46  $\mu\text{m}$  broad and 180-375  $\mu\text{m}$  long; chloroplast reticulate.

**Reproductive structures:** In the present collection reproductive structures were not observed.

**Locality:** Kasur District: Lulyani Village (6-1-2004).

**Syntype localities:** North Sea, Germany; Dubrovnik, Croatia.

**Geographical distribution:** U.S.A., Germany, Croatia, Pakistan, Australia.

**Remarks:** It was collected from stagnant water ponds of Lulyani Village during January. The temperature of water was about 6 °C. The specimens were only found in vegetative condition.

### Order Sphaeropleales

Protoplasm segregated into bands by vacuoles, the following genus was collected.

#### *Sphaeroplea* C. A. Agardh 1824: 76

Free floating filaments of long cylindrical multinucleate units, with thickened cross walls. The cells are divided into protoplasmic sections by large vacuoles. Chloroplasts numerous, ovate, narrow, ring like which vary in shape with age and so grouped as to form up to 30 parietal bands or zones within each cell. Sexual reproduction oogamous, non motile eggs and antherozoids produced in unmodified vegetative cells in the same or in separate filaments. Zygospores are red, with thick decorated walls. Only the following species could be collected:

##### 8. *S. annulina* (Roth) C. A. Agardh 1824

(West, 1904: 108; Prescott, 1962: 111; Ramanathan, 1962: 166;  
Masud-ul-Hasan & Batool 1987: 350)

**Basionym:** *Conferva annulina* Roth 1806.

**Morphological characters:** Unbranched filaments (Figs. 15, 16).

**Cytological features:** Long cylindrical cells united into unbranched filament; recognizable in vegetative condition because of numerous septation of cytoplasm with vacuoles between them, giving a sort of ladder effect in the cell; end walls unevenly thickened, side walls relatively thin; cells length 470-480 µm and width 35-40 µm.

**Reproductive structures:** Sexual reproduction oogamous; zygospore wall is not smooth, but decorated with spines.

**Locality:** N.W.F.P.: Attock: (12-1-2004).

**Geographical distribution:** U.S.A., U. K., India, Pakistan.

**Remarks:** The collection work was carried out during winter season of 2004, specimens were found mixed with different free floating algae. It occurred in vegetative as well as reproductive condition. During this season, temperature, pH of water and light intensity were favourable for its growth.

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