

## **TAXONOMIC STUDY OF THE FAMILY MESOTAENIACEAE (DESMIDIOPHYCEAE SHAMEEL) IN CERTAIN NORTH- EASTERN AREAS OF PAKISTAN**

**WAQAR-UL-HAQ<sup>1</sup>, A. ZARINA<sup>1</sup>, MASUD-UL-HASAN<sup>2</sup> AND MUSTAFA SHAMEEL<sup>3</sup>**

<sup>1</sup>*Department of Botany, Federal Urdu University of Arts, Sciences & Technology  
Gulshan-e-Iqbal Campus, Karachi-75300, Pakistan,*

<sup>2</sup>*Department of Botany, Govt. College University, Kachehri Road, Lahore-54000,*

<sup>3</sup>*Department of Botany, University of Karachi, Karachi-75270, Pakistan.*

### **Abstract**

Eleven species of saccoderm desmids (green microalgae) belonging to 5 genera of the family Mesotaeniaceae (order Mesotaeniales, class Desmidiophyceae, phylum Volvocophyta) were collected from various freshwater habitats of Gujranwala, Jhang, Lahore, Sargodha and Sheikhupura districts of the Punjab, Bahrain & Kalam in Swat and Attock (NWFP) of Pakistan as well as Chenari and Neelum Valley of Azad Kashmir during January 2005-April 2006. They were taxonomically investigated and have been described for the first time from these areas. These species were found to grow in all the seasons of the year but mostly occurred in spring and winter. The genera *Hyalotheca* and *Netrium* and the species *H. dissiliens*, *H. mucosa*, *N. digitus*, *N. oblongum*, *Pleurotaenium trabecula* and *Staurastrum inflexum* are being reported for the first time from Pakistan.

### **Introduction**

Several studies have been made in the past on the taxonomy of freshwater green macroalgae 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). Among such studies, the most poorly investigated group was of desmids. With this idea in mind, a large survey was carried out to collect desmids from various freshwater habitats of different districts of the Punjab and a few areas of NWFP and Azad Kashmir. Present paper is the first report in this connection.

### **Materials and Methods**

The specimens were collected by towing-net from different freshwater habitats of Gujranwala, Jhang, Lahore, Sargodha and Sheikhupura districts of the Punjab; Bahrain & Kalam in Swat and Attock (NWFP) & Chenari and Neelum Valley of Azad Kashmir during January 2005 and April 2006. They were carefully picked up with the help of a pipette, washed, preserved in plastic bottles containing 3% formalin and brought to the laboratory at Karachi. The material was examined under light microscope (Zeiss, Germany) and identified up to species level with the help of authentic literature (Børgesen, 1901; West, 1904; Krieger, 1950; Wasylik, 1961; Hirano, 1964; Biswas, 1975; Duthie & Ostrofsky, 1975; Wehr & Sheath, 2003; John *et al.*, 2005). The drawings were made with the help of camera lucida. The voucher specimens are kept in the Phycology & Phycochemistry Lab., MAH Qadri Biological Research Centre, University of Karachi, where this research work was carried out.

## Results and Discussion

Eleven species of saccoderm desmids (green microalgae) belonging to 5 genera of the family Mesotaeniaceae, order Mesotaeniales, class Desmidiophyceae Shameel, phylum Volvocophyta Shameel (*vide* Shameel, 2001) have been identified. Their taxonomic enumerations are as follows:

### Family Mesotaeniaceae

Unicellular, rod-shaped or oblong individuals; surrounded by a single piece of wall, which is thin and not constricted in the middle or slightly constricted; chloroplast may be a flat axil plate, with one and many pyrenoids or a pair of stellate, spiral, with scattered pyrenoids; nucleus in the center of the cell; reproduction by transeverse cell-division, followed by separation of daughter cells; sexual reproduction by conjugation. Following five genera were collected, which may be distinguished as follows:

1. Cell with a median constriction ..... 2  
    Cell without median constriction ..... 3
2. Median constriction very deep ..... *Euastrum*  
    Median constriction not deep ..... 4
3. Chloroplast paddle-wheel shaped, composed of longitudinal plates ..... *Netrium*  
    Chloroplast not as above ..... *Hyalotheca*
4. Poles of the cell rounded ..... *Cylindrocystis*  
    Poles of the cell attenuated ..... *Pleurotaenium*

### *Cylindrocystis* Meneghini ex de Bary 1858

Cells straight, cylindrical with rounded poles; solitary, embedded in mucilage; unconstricted or with a slight median constriction, apices rounded; one axil, substellate chloroplast in each semi-cell, each chloroplast with prominent pyrenoids; reproduction by transverse cell-division, followed by separation of daughter cells; sexual reproduction by conjugation, isogamous; conjugation canal formed between compatible cells, gametes move into the tube forming a zygospore. Only following species could be collected:

#### 1. *C. brebissonii* (Meneghini ex Ralfs) De Bary 1858

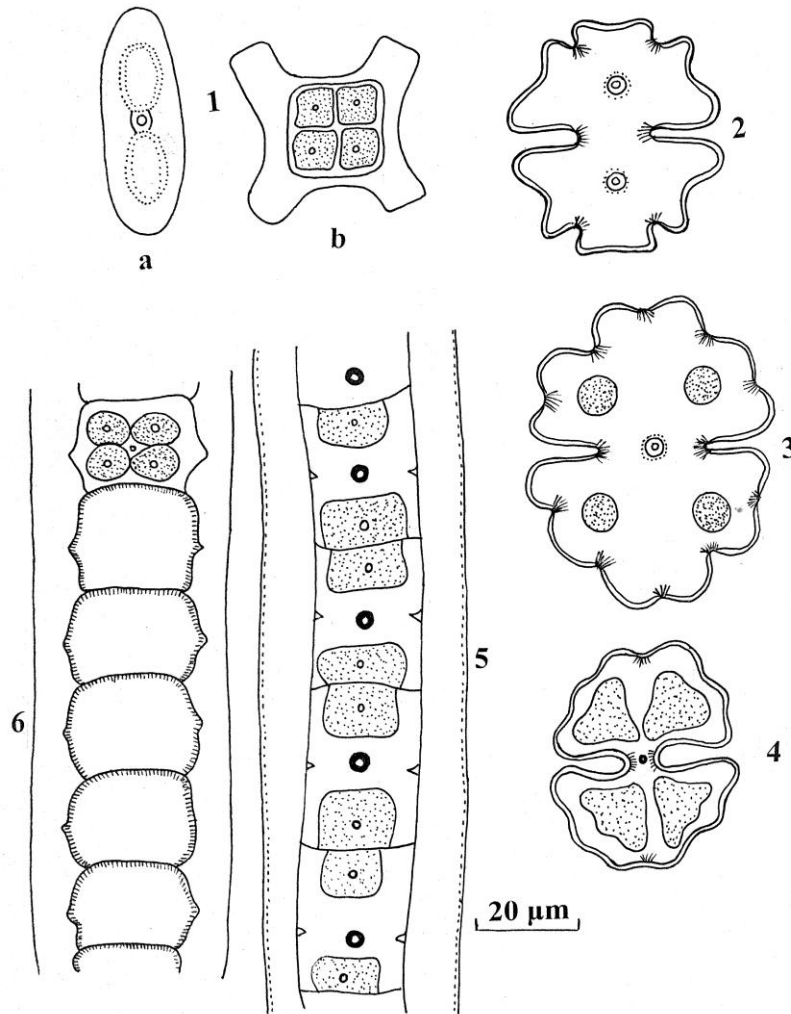
**References:** Børgesen, 1901: 211; West, 1904: 156; Wasylik, 1961: 269; Hirano, 1964: 211; Biswas, 1975: 571; Masud-ul-Hasan & Zeb-un-Nisa, 1986: 239; Wehr & Sheath, 2003: 363.

**Basionym:** *Penium brebissonii* Meneghini ex Ralfs.

**General characters:** Cells cylindrical, unconstricted, 2-4 times longer than broad, rounded at apices; chloroplasts 2, each with a pyrenoid and few radiating prolongations, often difficult of observation; cells 40-51 µm long and 13-15 µm broad (Fig. 1a); reproduction isogamous, zygospore in conjugation tube; zygospores 25-27 µm broad (Fig. 1b).

**Localities:** Azad Kashmir: Chenari (18-4-2005), Neelum Valley (26-4-2005).

**Geographical distribution:** U. S. A., England, Denmark, Poland and Afghanistan.



Figs. 1-6. Species of the family Mesotaeniaceae: 1. *Cylindrocystis brebissonii*: a. vegetative cell, b. showing conjugation, 2. *Euastrum inermius*, 3. *E. sculptum*, 4. *E. sinuosum*, 5. *Hyalotheca dissilliens*, 6. *H. mucosa*.

**Remarks:** It was collected from two different localities of Azad Kashmir during spring and was found in stagnant water channel.

***Euastrum* C. G. Ehrenberg ex Ralfs 1848: 479**

Cells of variable size, solitary, longer than broad, compressed, deeply constricted in the middle; sinus linear, semi-cells truncate, pyramidal; apex with one or more protuberances or tumours; vertical view more or less elliptical, with one or more protuberances on each side; one axile chloroplast in each semi-cell, often irregularly lobed and ridged; with a single pyrenoid in small species and a number of pyrenoids

scattered in large species. Following three species were collected, which may be distinguished as follows:

1. Cells more than 50  $\mu\text{m}$  long ..... *E. sculptum* (3)  
     Cells up to 50  $\mu\text{m}$  long ..... 2
2. Isthmus more than 11  $\mu\text{m}$  broad ..... *E. inermius* (2)  
     Isthmus up to 11  $\mu\text{m}$  broad ..... *E. sinuosum* (4)

### 2. *E. inermius* (Nordst) W. B. Turner

**Reference:** Shahida *et al.*, 2006: 176.

**General characters:** Cells composed of two halves, each half characterized by a notch at the apex; single chloroplast in each half with a pyrenoid; cells 50-52  $\mu\text{m}$  long; isthmus 13-14  $\mu\text{m}$  broad (Fig. 2).

**Locality:** Sargodha District: Rabwah, near factory area (30-8-2005)

**Geographical distribution:** Previously reported from India.

**Remarks:** The specimens were collected from stagnant water pool, near factory area during the rainy season of summer.

### 3. *E. sculptum* Ehrenberg *ex* Ralfs 1848

**Reference:** Shahida *et al.*, 2006: 176.

**General characters:** Cells composed of two halves, each half characterized by a notch at the apex, two chloroplasts in each half; two pyrenoids in each semi-cell; cells 57-60  $\mu\text{m}$  long and 44-46  $\mu\text{m}$  broad; isthmus 17-18  $\mu\text{m}$  broad (Fig. 3).

**Locality:** Jhang District: near Chund (20-1-2005); Sargodha District: Rabwah, Chenab River (30-8-2005).

**Geographical distribution:** Previously reported from Europe, Japan, Brazil.

**Remarks:** The collection was made from two different areas during winter and summer. It occurred in free-floating state in large quantity.

### 4. *E. sinuosum* Lenomand *ex* W. Archer

**References:** Børgesen, 1901: 212; Krieger, 1950: 39; Wasylik, 1961: 274; Duthie & Ostrofsky, 1975: 261; Masud-ul-Hasan & Yunus, 1989: 117; John *et al.*, 2005: 556.

**General characters:** Cells 45-47  $\mu\text{m}$  long, 31-32  $\mu\text{m}$  wide; isthmus 10-11  $\mu\text{m}$  wide; cells small, sinus narrowly linear with dilated extremities, deeply constricted; semi-cells elongate, pyramidal; polar tube prominent, lobe rounded, cell-wall punctate; depression on tips of semi-cells (Fig. 4).

**Locality:** Sheikhpura District: near Narang Mundi and Mureedke (16-9-2005).

**Geographical distribution:** Previously reported from Canada, Europe, Japan and Brazil.

**Remarks:** The specimens were collected from paddy field during autumn, where it was found in free-floating state.

### *Hyalotheca* C. G. Ehrenberg *ex* Ralfs 1848

Cells arranged in a linear fashion to form unbranched chains or filaments; which are surrounded by a copious gelatinous sheath; cells short, cylindrical inconspicuously indented at the isthmus; each with two chloroplasts, embedded with pyrenoids; growth of

filaments result from desmediacian division of cell; reproduction by fragmentation; conjugation occurs between compatible individuals and conjugation tube is also formed; meiosis is zygotic. The present genus is being reported for the first time from Pakistan and its following two species were collected, which may be distinguished as follows:

1. Cells up to 26  $\mu\text{m}$  long, with single pyrenoid ..... *H. dissilliens* (5)  
Cells more than 26  $\mu\text{m}$  long, with two pyrenoids ..... *H. mucosa* (6)

#### 5. *H. dissilliens* de Brébisson ex Ralfs 1848: 51

**References:** West, 1904: 176; Wasylik, 1961: 281; Duthie & Ostrofsky, 1975: 266; John *et al.*, 2005: 589.

**General characters:** Cells united to form long filament; which are not twisted, generally enclosed by a copious gelatinous envelope; cells usually somewhat longer than broad; median constriction very slight; end-wall of cells plane and without projection; polar angles usually rounded, cell-wall without ornamentation; chloroplast axil with several vertical lobes that extend to the cell-wall; pyrenoid single and central; cells 25.5-26.0  $\mu\text{m}$  long and 18-20  $\mu\text{m}$  broad (Fig. 5).

**Locality:** Jhang District: Trimmu Head Works (6-1-2005).

**Geographical distribution:** U.S.A., Canada, England and Poland.

**Remarks:** The present collection was obtained from a temporary pond near Trimmu Head Works during winter. It was found in massive quantity, occurring in vegetative as well as reproductive conditions. This species is being reported for the first time from Pakistan.

#### 6. *H. mucosa* (Mertens) Ehrenberg ex Ralfs 1948: 53

**References:** West, 1904: 176; Duthie & Ostrofsky, 1975: 266; John *et al.*, 2005: 589.

**Basionym:** *Conferva mucosa* Mertens.

**General characters:** Filamentous thallus; cells rectangular; surrounded by wide gelatinous sheath; vegetative cells 30-31  $\mu\text{m}$  long and 23-24  $\mu\text{m}$  broad; chloroplast with two pyrenoids (Fig. 6).

**Locality:** Gujranwala District: Nandipur (4-4-2005).

**Geographical distribution:** World-wide.

**Remarks:** The materials were collected during spring, from paddy field. It was found along with other filamentous free-floating algae. The present species is being reported for the first time from Pakistan.

#### *Netrium* (Nägeli) Itzigsohn ex Roth in Rabenhorst 1856

Shape of cell varies from fusiform to cylindric, no median constriction; chloroplast paddle-wheel shaped, composed of longitudinal plates, radiating around central axis. This genus is also being reported for the first time from Pakistan. Its following two species were collected, which may be distinguished as follows:

2. Cells elliptical with sharp poles ..... *N. digitus* (7)  
Cells cylindrical with rounded poles ..... *N. oblongum* (8)

### 7. *N. digitus* (Ehrenberg ex Ralfs) Itzigsohn ex Roth 1856

**References:** West, 1904:156; Krieger, 1950: 35; Wasylik, 1961: 269; Duthie & Ostrofsky, 1975: 258; Wehr & Sheath, 2003: 358; John *et al.*, 2005: 513.

**Basionym:** *Penium digitus* Ehrenberg ex Ralfs.

**General characters:** Cells elliptic with sharp poles; chloroplast paddle-wheel type; length 197-198 µm and width 44-45 µm (Fig. 7).

**Locality:** N.W.F.P.: Swat, between Bahrain and Kalam (4-8-2005)

**Geographical distribution:** U.S.A., Canada, Brazil, England and Poland.

**Remarks:** The specimens were obtained during rainy season of summer. It was found in slow running water, only in vegetative condition. This species is being reported for the first time from Pakistan.

### 8. *N. oblongum* (de Bary) Lutkemüller 1856

**References:** West, 1904: 156; Krieger, 1950: 35; Wasylik, 1961: 269; Duthie & Ostrofsky, 1975: 259; Wehr & Sheath, 2003: 358; John *et al.*, 2005: 514.

**Basionym:** *Penium oblongum* de Bary.

**General characters:** Cells cylindric in shape with rounded poles, length 80-85 µm and width 19-21 µm (Fig. 8).

**Locality:** N.W.F.P.: Swat, between Bahrain and Kalam (4-8-2005).

**Geographical distribution:** U.S.A., Canada, Brazil, England and Poland.

**Remarks:** These specimens were also collected alongwith *N. digitus* from slow running water along the bank of river during summer. It was also found in vegetative condition only. This species is also being reported for the first time from Pakistan.

### *Pleurotaenium* Nägeli 1849: 104

Cells usually quite large, length several times than breadth; median constriction well defined but not deep; cells solitary; always straight; semi-cells never compressed, commonly cylindrical and somewhat attenuated towards the poles, being always truncate; chloroplasts usually numerous and parietal, containing several pyrenoids. Following two species have been collected, which are distinguished as follows:

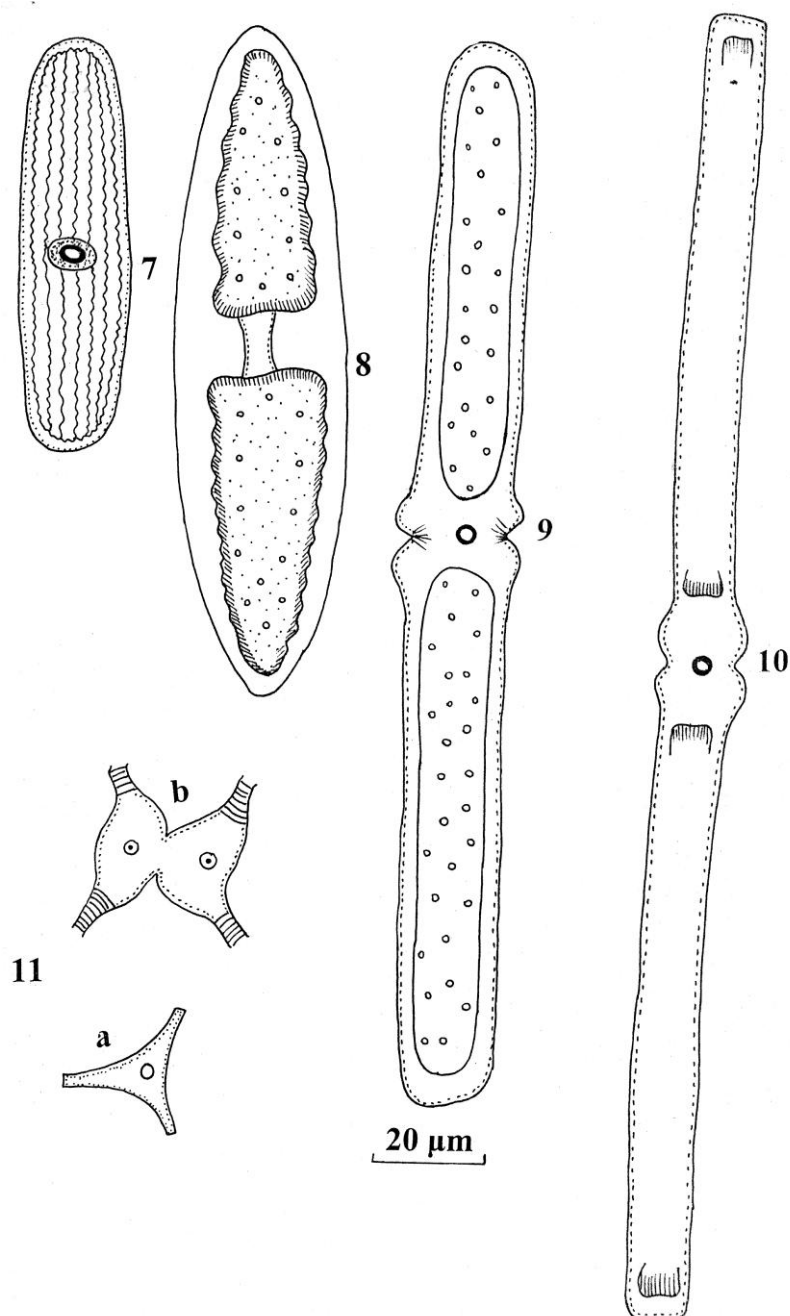
2. Vegetative cells up to 520 µm long ..... *P. ehrenbergii* (9)
- Vegetative cells larger, more than 520 µm long ..... *P. trabecula* (10)

### 9. *P. ehrenbergii* (Brébisson in Ralfs) de Bary 1858: 75

**References:** Børgesen, 1901: 212; West, 1904: 163; Wasylik, 1961: 272; Duthie & Ostrofsky, 1975: 260; Masud-ul-Hasan & Batool, 1987: 352; Masud-ul-Hasan & Yunus, 1989: 117; Leghari *et al.*, 2002: 77; John *et al.*, 2005: 562; Shahida *et al.*, 2006: 176.

**Basionym:** *Docidium ehrenbergii* Brébisson in Ralfs.

**Synonymy:** *P. ehrenbergii* (Brébisson) de Bary var. *constrictum* (Playfair) Willi Krieger, *P. ehrenbergii* (Brébisson) de Bary var. *granulatum* (Ralfs) West et G. S. West, *Docidium ehrenbergii* var. *elongatum* W. West.



Figs. 7-11. Species of the family Mesotaeniaceae: 7. *Netrium digitus*, 8. *N. oblongum*, 9. *Pleurotaenium ehrenbergii*, 10. *P. trabecula*, 11. *Staurastrum inflexum*: a. vegetative cell, b. showing conjugation.

**General characters:** Cells elongated, cylindrical; tapering slightly to truncate apices, which are decorated with a circle of 8-9 tubercles; slightly constricted at mid region; two distinct undulations at the base of semi-cells and slight ones often present beyond these; chloroplast as longitudinal bands, with small pyrenoids scattered through them; length of cells 507-520 µm and width 30-33 µm (Fig. 9).

**Localities:** Lahore District: (3-4-2005); Sargodha District: Rabwah, Chenab River (6-3-2005); N. W. F. P. : Attock (23-1-2005), (22-4-2006).

**Geographical distribution:** Previously reported from Europe, China and India.

**Remarks:** It was collected during winter and spring from two different habitats: near paddy fields and temporary stagnant water ponds, mixed with other free-floating algae in vegetative as well as reproductive conditions.

#### 10. *P. trabecula* (Ehrenberg) Nägeli 1849

**References:** West, 1904: 163; Wasylik, 1961: 272; Duthie & Ostrofsky, 1975: 260; John *et al.*, 2005: 562.

**Synonymy:** *Docidium ehrenbergii* var. *delpontei* f. *constricta* Playfair.

**General characters:** Cells elongated, cylindrical, slightly constricted at mid region; tapering slightly to truncate, unornamented apices; semi-cells with basal swelling; cells 364-620 µm long and 30.6-32.0 µm broad (Fig. 10).

**Locality:** Jhang District: near Trimmu Head Works (8-1-2005).

**Geographical distribution:** U.S.A., Canada, England and Poland.

**Remarks:** The material was collected during winter from a pond mixed with other free-floating algae. It was found in large quantity. This species is being reported for the first time from Pakistan.

#### *Staurostrum* (Meyen) Ralfs 1848

Cells triangular in vertical view; angles extended into armed tips with three short spines; deep sinus visible in side view. Only following species could be collected:

#### 11. *S. inflexum* de Brébisson 1856: 140

**Reference:** John *et al.*, 2005: 570.

**General characters:** Vertical view of cell triangular; angles extended into armed tips, with three short spines; margin of arms undulate, surface concentrically ringed with granules; side view with deep sinus; cells 22-23 µm long and 20-21 µm broad; isthmus 8.5-9.0 µm broad (Figs. 11a, b).

**Locality:** Jhang District: Chenab river near Chund (4-1-2005).

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

**Remarks:** The specimens were collected during winter. It was found in a pond, along the bank of river. This species is being reported for the first time from Pakistan.

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