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# OCCURRENCE OF PENNATE DIATOMS (BACILLARIOPHYTA) IN THE PUNJAB AND N. W. F. P., PAKISTAN

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**Abstract**

Seven species of diatoms, belonging to 6 genera and 5 families of the order Bacillariales were collected from various freshwater habitats of Gujranwala, Lahore and Sialkot districts of the Punjab and Attock of N. W. F. P. (Pakistan) during January and December 2004. They were taxonomically evaluated and described for the first time from their area of collection. They usually occurred in winter and spring, no sexual reproduction was observed in them. Among them, the genus *Cymatopleura*, its two species such as *C. elliptica, C. solea* and *Tabellaria fenestrata* are being reported for the first time from Pakistan.

## Introduction

During 2003-2006 a large collection of pennate diatoms was made from various districts of the Punjab and certain areas of N.W.F.P. and Azad Kashmir. From this collection some of the genera like *Cymbella* C.A. Agardh, *Navicula* Bory *emend*. Cleve and *Nitzschia* Hassall as well as the genera of the family Pinnulariaceae have been taxonomically determined and described (Tariq-Ali *et al*., 2006a-d, 2007). The present investigation is a continuation of these studies, where genera of 5 diatomaceous families have been taxonomically described.

## Materials and Methods

Water samples containing diatoms were obtained from different freshwater habitats of Gujranwala, Lahore and Sialkot districts of the Punjab and Attock of N.W.F.P. (Pakistan) during January and December 2004. From these samples, diatoms were carefully picked up with the help of a dropper, preserved in plastic bottles containing 3% formaldehyde and brought to the laboratory at Karachi. The specimens were mounted in 10% glycerine and examined under stereo-microscope. The methods used for the collection, preservation and microscopic examination of the material as well as preparation of their drawings were the same as described earlier (Tariq-Ali *et al*., 2006c, d). The specimens were identified up to species level with the help of authentic literature (West, 1904; Østrup, 1908; Salim & Khan, 1960; Starmach, 1964; Foerster & Schlichting Jr., 1965; Gerloff & Lüdemann, 1966; Giffen, 1966; Cholnoky, 1970; Nizamuddin, 1984). The voucher specimens are kept in the Phycology & Phycochemistry Lab. (Room No. 18), M. A. H. Qadri Biological Research Centre, University of Karachi, where this study was carried out.

## Results and Discussion

After examining the morphological and cytological characters, 7 species of diatoms belonging to 6 genera and 5 families of the order Bacillariales have been identified. They are systematically arranged according to the classification of Shameel (2001), which has been incorporated in the new edition of the International Dictionary, New Syllabus of Plant Family Names (a revised continuation of the world known Engler's Syllabus der Pflanzenfamilien, published in 1892-1954), published by NICAR, Moscow, Russia. Descriptions of the relevant taxa are given below:

### Family Swirellaceae

Valves linear, naviculoid or elliptical, broadly costate; longitudinal pseudoraphe; single chromatophore sometimes producing lobes. The present collection included the following genus only.

### *Cymatopleura* W. Smith 1851: 12

Frustules linear in girdle view with undulated margins; valves linear, naviculoid or elliptic, transversely undulate on the face, with a marginal keel containing raphe; broadly costate at the periphery, sometimes very short; transverse striations interrupted by longitudinal pseudoraphe; chromatophore single, appearing as two expanded lobes, one next to each valve, connected by cytoplasmic bridge. This genus is being reported for the first time from Pakistan. Its following two species have been collected, which may be distinguished as follows:

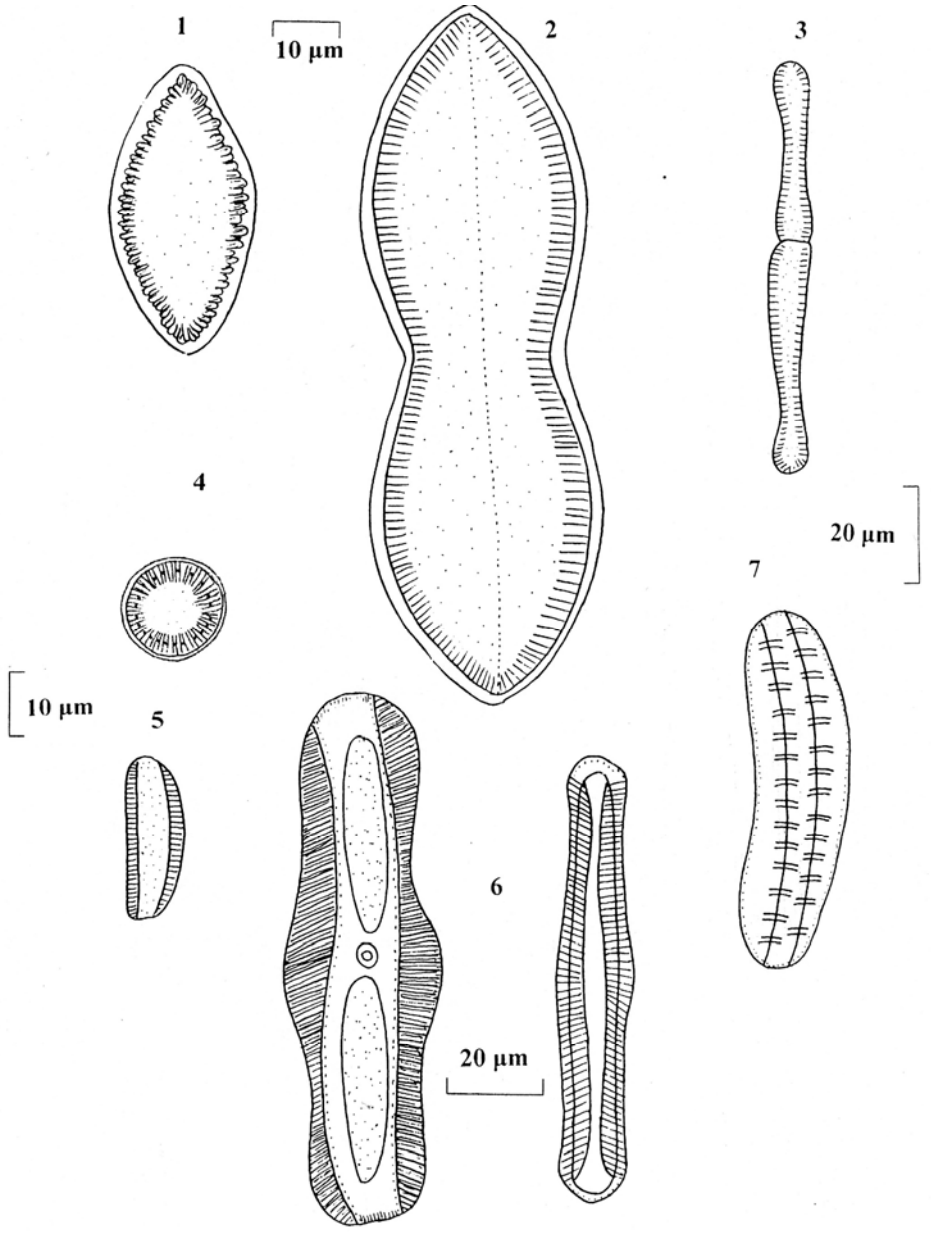
1. Valves small, up to 30 µm long …… *C. elliptica* (1)
   Valves large, more than 70 µm long ……. *C. solea* (2)

#### 1. *C. elliptica* (de Brébisson) W. Smith 1857

**Reference:** Starmach, 1964: 538.
**General characters:** Valves 30 µm in length and 16 µm in breadth (Fig. 1).
**Cytological features:** Chromatophore single.
**Locality:** Gujranwala District: Qadyan (20-12-2004).
**Geographical distribution:** Afghanistan, Poland.
**Remarks:** The specimens were collected during winter from a roadside pond near Qadyan. Sexual reproduction was not observed. The material was obtained in vegetative form only. This species is being reported for the first time from Pakistan.

#### 2. *C. solea* (de Brébisson 1835) W. Smith

**Basionym:** *Cymbella solea* de Brébisson 1835.
**Reference:** Starmach, 1964: 536.
**General characters:** Valve 73-206 µm in length and 21-32 µm in breadth (Fig. 2).
**Cytological features:** Choromatophore single.
**Locality:** Gujranwala District: Kotti Dil Bag Ria (21-12-2004).




Figs. 1-7. Diatoms from Punjab and N. W. F. P., Pakistan: 1. *Cymatopleura, elliptica*, 2. *C. solea*, 3. *Tabellaria fenestrata*, 4. *Cyclotella operculata*, 5. *Epithemia argus*, 6. Two views of *Rhopalodia gibba*, 7. *Eunotia arcus*.

**Geographical distribution:** Japan, Afghanistan, Sumatra, Poland.
**Remarks:** The specimens were collected during winter from a roadside pond at Kotti Dil Bag Ria. Sexual reproduction was not observed. The material was obtained in vegetative form. This species is also being reported for the first time from Pakistan.

**Family Tabellariaceae**

Frustules are with two to many intercalary bands, cells are tubular in girdle view, parallel to the intercalary band and between them. As seen in valve view the cells are narrowly linear, bilaterally symmetrical and partially inflated, midway between the poles. The pseudoraphe is axial and finely punctate. Numerous small, discoid chromatophores. Frustules conjoined in straight or zig-zag chains by means of gelatinous cushions at their corners. The present collection included the following genus.

***Tabellaria* C. G. Ehernberg 1830 *ex* F. T. Kützing**

Frustules quadrangular, adnate in filaments, frequently found in zigzag chains, united by an isthmus, at length separating; valve linear, inflated in the middle and at the ends; striae transverse. Chromatophores numerous, small along the zones. The following species was found in the present collection.

**3. *T. fenestrata* (Lyngbye) Kützing 1844**

**Basionym:** *Diatoma fenestrata* Lyngbye.
**References:** West, 1904: 282; Østrup, 1908: 288; Starmach, 1964: 133; Foerster & Schlichting Jr., 1965:491; Gerloff & Lüdemann, 1966: 107.
**General characters:** Valve elongated, pseudoraphe narrow; transverse striae faint; in zonal view straight septum shown at each end of a vlave (Fig. 3).
**Cytological features:** Chromatophores numerous, small, along the zones.
**Locality:** Lahore District: Jinnah Garden (9-3-2004).
**Geographical distribution:** USA: New Jersey; Ontario (Canada), Poland, Faeröes (Denmark).
**Remarks:** The specimens were collected during spring from fountains of Jinnah Garden. Sexual reproduction was not observed. The material was obtained in vegetative form only. This species is being reported for the first time from Pakistan.

**Family Thalassiosiraceae Le Bour 1930**

Frustules geminate, girdle rectangular; valve disc shaped, punctate, with radiating striae; scattered granules; many rounded chromatophores. Only following genus was found in the present collection.

***Cyclotella* (Kützing) de Brébisson 1838**

Frustules solitary or geminate; girdle rectangular or with undulate sides; valve disc shaped having two concentric areas, inner one smooth or with granules scattered and outer one with finely punctate radiating striae; chromatophores many, rounded; microspores formed within the cells. It included only following species in the present collection.

### 4. *C. operculata* (C. A. Agardh) Kützing 1834: 535

**Basionym:** *Frustulia operculata* C. A. Agardh.
**References:** West, 1904: 276; Salim & Khan, 1960: 15; Starmach, 1964: 106; Cholnoky, 1970: 11; Nizamuddin, 1984: 42; Inam *et al*., 1986: 2; Daudpota & Leghari, 1993: 122.
**General characters:** Frustules in zone view undulate, a little depressed towards the centre, mostly forming pairs; valve circular, 13 µm in diameter; striae distinct, arranged radially, somewhat thicker near the margin; central area smooth (Fig. 4).
**Cytological features:** Chromatophores many, rounded.
**Locality:** N. W. F. P.: Attock (11-1-2004).
**Geographical distribution:** Pakistan: Peshawar; Libya, Poland.
**Remarks:** The specimens were collected during winter from a stagnant pond with other free-floating algae near Attock. Sexual reproduction was not observed. The material was obtained in vegetative form.

## Family Epithemiaceae Grunow 1860

Solitary frustules, rectangular; free-floating; girdles smooth with intercalary bands; linear or elliptical; valves elongate or lunate, curved, dorsally convex; striae delicate; raphe along the convex edge with polar and central nodules; single chromatophore with projections, elongate. In the present collection, following two genera were collected, which may be distinguished as follows:

1. Valves slightly to strongly curved ……..... *Epithemia*
   Valves elongate or lunate ……..... *Rhopalodia*

### *Epithemia* de Brébisson 1844: 33

Cells solitary, attached at the girdle; rectangular in girdle view, girdles smooth with intercalary bands; valves slightly to strongly curved, dorsaly convex; raphe with polar and central nodules; a single chromatophore with irregular projections. The present collection included only the following species.

### 5. *E. argus* (Ehrenberg 1843) Kützing 1844: 33

**Basionym:** *Eunotia argus* Ehrenberg 1843.
**References:** West, 1904: 301; Østrup, 1908: 278; Salim & Khan, 1960: 52; Starmach, 1964: 479; Nizamuddin, 1984: 52; Inam *et al*., 1986: 2; Leghari & Sultana, 1993: 16.
**General characters:** Frustules solitary or in groups; valve acute, dorsal side convex and ventral plane-concave; ends rounded, raphe curved, V-shaped on the ventral side; cell length 48-49 µm and breadth 14-15 µm; costae 4 within 10 µm (Fig. 5).
**Cytological features:** Chromatophore single, with projections.
**Locality:** Lahore District: Mahmood Booti (25-1-2004).
**Geographical distribution:** Pakistan: Peshawar, Lahore; Libya, Poland, Faeröes (Denmark).
**Remarks:** The specimens were collected during winter from a roadside pond near Mahmood Booti. Sexual reproduction was not observed. The material was obtained in the vegetative form.

***Rhopalodia* O.F. Müller 1895: 57**

Frustules solitary or in groups, free-floating; girdle linear or elliptical, broad in the middle with rounded poles; valve elongate or lunate, dorsal side convex, inflated in the middle, ends acute or incurved; costae transverse and well marked, intervening one or two rows of delicate striae; raphe along the convex edge, situated in keel like portion with indistinct central and polar nodules; chromatophore one, elongate, irregularly lobed. Following species was found in the present collection.

**6. *R. gibba* (Ehrenberg 1832) O. F. Müller 1895: 65**

**Basionym:** *Naviculla gibba* Ehrenberg 1832.
**Synonymy:** *Eunotia gibba* (Ehrenberg) Ehrenberg 1843, *Epithemia gibba* (Ehrenberg) Kützing 1844.
**References:** Salim & Khan, 1960: 54; Starmach, 1964: 487; Gerloff & Lüdemann, 1966: 108; Giffen, 1966: 284; Cholnoky, 1970: 33; Nizamuddin, 1984: 99; Leghari & Sultana, 1993: 16.
**General characters:** Frustules solitary or in groups, linear with medianly inflated sides narrowing towards the broadly rounded ends; valve linear, dorsal side arcuate and ventral side straight, but bent at the ends, ends acute; costae transverse, 6-8 within 10 μm; cell-length 80-82 μm and breadth 11-13 μm (Fig. 6).
**Cytological features:** Chromatophore one, elongate, irregularly lobed.
**Locality:** Sialkot District: Punnowal (20-4-2004).
**Geographical distribution:** Pakistan: Peshawar; Libya, Poland.
**Remarks:** The specimens were collected during spring from road side puddle near Punnowal. Sexual reproduction was not observed. The material was obtained only in the vegetative form.

**Family Eunotiaceae Kützing 1844**

Furstules linear to rectangular; girdle strongly ornamented; valves arcuate, raphe short; no central nodule, no costa and no septum; chromatophores two, laminate, without pyrenoid. The following genus was found in the present collection.

***Eunotia* Ehrenberg 1837: 45**

Cells rectangular to linear in girdle view; both girdle and valves strongly ornamented, usually with intercalary bands; valves arcuate with similar poles but dissimilar margins; raphe very short, extending from fairly evident polar nodule diagonally to concave margin, no central nodule; neither costae nor septa present; two somewhat laminate chloroplasts, without pyrenoids. The present collection included the following species only.

**7. *E. arcus* Ehrenberg 1838: 191**

**References:** Østrup, 1908: 279; Salim & Khan, 1960: 21; Starmach, 1964: 199; Nizamuddin, 1984: 53.

**General characters:** Frustules solitary, free; valve arcuate, dorsal side smoothly convex, ventral side nearly straight; apices slightly produced, rounded; striae transverse, fine; nodules terminal, comma shaped; frustule length 33 µm and breadth 13-14 µm (Fig. 7).
**Cytological features:** Chromatophores two, without pyrenoids.
**Locality:** Lahore District: Head Marala (8-3-2004).
**Geographical distribution:** Pakistan: Peshawar, Lahore; Libya, Poland, Faeröes (Denmark).
**Remarks:** The specimens were collected during spring from pools near Head Marala. Sexual reproduction was not observed. The material was obtained in vegetative form only.

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