



## Distribution Pattern of Diatoms in District Bannu, Khyber Pakhtoonkhwa, Pakistan

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### ABSTRACT

The present work was undertaken as part of M.Phil dissertation to explore the distribution pattern of Diatoms in District Bannu, so far a little work has been done and less attention has been given to Diatoms. A total of 18 species of diatoms *taxa* belonging to 8 genera were collected and identified from various habitats of Bannu such as in lotic & lentic water of Kurram river, Tarkhobi alged, Tangai alged, Kashu river, Tochi river, Barran nallah, Doab, Khalboi alged, Khochkat river & Barran Dam. They were taxonomically determined and described for the first time from these areas. These genera are *Nitzschia*, *Cymbella*, *Cocconeis*, *Cyclotella*, *Gyrosigma*, *Gomphonema*, *Surirella* & *Pinnularia* with following species, *Cymbella affinis*, *C.cistula* *C.cymbiformis*, *C.naviculiformis*, *C.prostrata*, *Cocconeis placentula*, *Cyclotella meneghiniana*, *C.operculata*, *Gyrosigma acuminatum*, *G.attenuatum*, *Gomphonema acuminatum* *G.constrictum*, *G.gracile*, *G.geminatum*, *Surirella splendida* and *Pinnularia viridis*. The dominant genus is *Cymbella* having 5 species followed by *Gomphonema* with 4 species.

**Keywords:** Diatoms flora, Bannu, identification, preservation.

### INTRODUCTION

District Bannu is situated in the North-West Frontier Province of Pakistan. It lies between 32.43 to 33.06 North latitude and from 70.22 to 70.57 East longitudes. Geographically, the modern day Bannu is located in the heart of the southern region with its boundaries touching the districts of Karak, Lakki Marwat and the North, South Waziristan Agencies. The total area of the district is 1227 square kilometers. Bannu district is approximately 192 kilometers to the south of Peshawar and lies in a sedimentary basin. It is flanked and guarded on all sides by the hard and dried mountain ranges of Koh-e-Safed and Koh-e-Suleiman. It is a scenic part of the southern region, due to the "Kurram" river and its tributaries. They have made it a land of meadows, crops and orchards. Every kind of crop and fruit can be grown in it, but the banana, dates, figs and rice are unique in their taste, smell and shape. The important rivers are Kurram and Tochi.. Kurram River enters the district at north west corner and passes through the district in a south east direction. The Touchi river enters the south of Kurram river and flows out of the district first to the east and then to the south-eastern direction. Between these two rivers the area is called 'DOAB' which is irrigated by different canals. The prominent tributaries joining Kurram river on its left bank include Tangai alged, Khalboi/Tarkhobi alged and Kashhu alged while prominent Nallah is Barran or Lohra alged. The weather of Bannu district is moist & hot. It is suitable for growth of different flora. Due to maximum rainfall occur in august (111.36 mm) so maximum collection of Diatom is possible during august. Diatom is a heterogeneous group of phytoplankton which is present in the sea and freshwater (Battish, 1992). Mostly live in open water, although some live as surface films at the water-sediment interface benthic, or even under damp atmospheric conditions. They are especially important in oceans, where they are estimated to contribute up to 45% of the total oceanic primary production. These are generally classified on the basis of symmetry of the frustules. Those with radial symmetry are called centric diatoms and those with axial symmetry are called pinnate diatom there are more than 200 genera of living diatoms, and it is estimated that there are approximately 100,000 extant species. Diatoms preserved in sediments can provide records of environmental change at time scales ranging from seasonal to millennial (Battarbee, 1986, 1991). The first investigation on diatoms was made by West & West (1902) from the region now included in Pakistan. Later on Carter (1926) reported 49 species, Salim & Khan (1960) described 102 species of Peshawar valley (N.W.F.P.) of Pakistan. Investigations on diatoms from coastal waters of Pakistan were also made (Salim, 1954; Salim & Iqbal, 1964; Saifullah & Moazzum, 1978; Ghazala, 2006, 2007, 2009). Fresh water diatoms of Sindh (Leghari *et al.*, 2002, 2003, 2004, ; Leghari & Leghari, 2002), Punjab, N. W. F. P. Twenty-six species belonging to Diatomales were recorded for the first time, from the Saiful Malook lake, Kaghan valley (Sultan *et al.*, 2002) and Azad-Kashmir (Masud-ul-Hasan & Zeb-un-Nisa, 1986, Masud-ul-Hasan & Batool, 1987; Masud-ul-Hasan & Yunus, 1989; Leghari MK *et al.*, 2002, 2003, 2004; Leghari & Sultana, 1991; Tariq-Ali *et al.*, 2006b, c, d). But no survey was conducted in the Bannu region. So research programmed has been started in April 2012 to investigate distribution pattern of diatoms from different habitats in Bannu region.

## MATERIALS AND METHODS

The Collection was made during various seasons of 2011-12 from fresh water as well as from brackish water of Bannu region water samples containing diatoms were obtained from different freshwater habitat of district Bannu, K.P.K (Pakistan). Samples were collected from ponds, rivers, stream, standing & running water in district Bannu. Diatom samples were scraped from 5-10 stones (or other substrates) from each site. The stones were scratched with a toothbrush. The samples were kept in clean small plastic bottles, up-to 10m depth .The bottles were labeled accordingly and brought to the laboratory at USTB in order to study further. After 24 hours, were carefully picked up with the help of a dropper 1 ml of sample was poured onto the slide sample. Three replicas were made of each bottle for microscopic identification. The specimens were mounted in 10% glycerin and examined under Labomed -microscope in the laboratory of University of science & technology Bannu. The specimens were identified up to species level according to Salim 1954, Salim and Iqbal 1964, Bradbury 1975, Tiffany and Britton 1952 and Battarbee 1986. All species were measured with help of micrometer separately. The pictures of identified species were taken with the Cyber Shot Sony Camera. The data was compared with the standard key available in monographs. The samples were preserved in plastic bottles containing 3% formaldehyde. The methods used for the collection, preservation and microscopic examination of the material as well as preparation of their drawings were same as described earlier (Tariq-Ali *et al.*, 2006). All the specimens were deposited & preserved in the Herbarium of the University of Science & Technology Bannu.

**Table 1. Name of the places of research area**

Kurram river	Touchi river
Doab	Tangai alged
Khalboi alged	Tarkhobi alged
Kashhu alged	Barran or Lohra alged
Kochkat river	Barran dam

## RESULTS AND DISCUSSION

The present work was undertaken as a part of M.Phil dissertation to explore the Diatoms of District Bannu, so far a little work has been done and less attention has been given to Diatoms (Shah 1996, Sultan *et al.*, 2004). A total of 18 species belonging to 8 genera of Diatoms were collected and described taxonomically. The dominant genus was *Cymbella* having 5 species and *Gomphonem* having 4 species.

**Table 2. Genera and Species Distribution**

S.No	Name of the Genus	No. of species	Name of species
1.	<i>Nitzschia</i>	02	<i>palea,vermicularis.</i>
2.	<i>Cymbella</i>	05	<i>affinis, cistula,cymbiformis, naviculiformis,prostrata.</i>
3.	<i>Cocconeis</i>	01	<i>placentula</i>
4.	<i>Cyclotella</i>	02	<i>menenghiana,operculata.</i>
5.	<i>Gyrosigma</i>	02	<i>acuminatum, attenuatum.</i>
6.	<i>Gomphonema</i>	04	<i>acuminatum,constrictum, gracile,geminatum.</i>
7.	<i>Surirella</i>	01	<i>splendida.</i>
8.	<i>Pinnularia</i>	01	<i>viridis</i>

### Description of the collected eight Genera and 18 Species

#### *I. Cocconeis plancentula* var. *lineate*. Ehreberg.( Fig.1 )

**Morphology:** Striae in longitudinal and transverse series with isolated punctae (punctae lines in this case) and hyaline areas appearing towards the margin.

**Dimension:** length =26u, Breadth =15u, No. of striae /10u =22.26

**Habitat:** collected from stone surface on the sides of a fresh water at Baran nallah, forming a brownish scum, Touchi river, Doab.

## 2. *Cyclotella*

**Morphology:** Cells short, drum-shaped, free-living or forming filaments, chains or rarely clusters, united by mucilage. Plastids numerous, discoid. Mainly freshwater and planktonic, with two species occurring in shallow coastal waters, probably as an evolutionary invasion from brackish waters. Valves circular (oval and triangular species have been found in fossil material from the Miocene, and oval ones very rarely in modern samples), with either a tangential or concentric undulation of the valve face. Rows of areolae extending from valve centre (or absent from centre), becoming grouped into fascicles on the outer region of valve face, and continuing to the valve edge without a break; no distinctive valve mantle in most species; scattered areolae in the central region in some species. Central area often ornamented with warts, granules, etc.

### i. *Cyclotella operculata*: kg.(Fig.2)

**Morphology:** Frustules strongly undulate tangentially, valve circular slightly depressed in the center. Marginal zone variable in width. Striae smooth reaching up to the middle of the radius. A ring of punctae is present at a distance within the margin.

**Dimension** = 16u. No. of striae = 12 in 10u

**Habitat:** from pool margins in barran nallah, Touchi river and Kashhu river,

### ii. *Cyclotella menenghiana*: kg. (Fig.3)

**Morphology:** Outer zone broad central zone smooth or finally radials punctuate, often, with a large *Isolated puncta*.

**Dimension:** Diameter =16.2u, No. of striae = 8-9

**Habitat:** collected by scarping at Baran nallah; from submerged stone in a spring at tochi river & Kashu river.

### 3. i. *Gyrosigma attenuatum* (kg.) Cleve. (Fig.4)

**Morphology:** Valves slightly sigmoid lanceolate, gradually tapering to round poles, transverse striation perpendicular to the middle line. Both transverse and longitudinal striations are present in distinct in this case.

**DIMENSION: Length= 174u, Breadth= 21u**

**Habitat:** Scarped from surface on the sides of a freshwater canal at lohra , forming a brownish scum , Doab & Tochi river.

### ii. *Gyrosigma acuminatum var. tumid var. novo*.(Fig.5)

**Morphology:** Valves sigmoid lanceolate, gradually attenuated to round poles, transverse striation perpendicular to the middle line. Differ from the type in the number of striation and in being broader

**DIMENSION:** Length =153u, Breadth =25u, No.of striae/10u = 13-15

**Habitat:** Collected by scarping from the stone surface on the side of a fresh water canal and by towing lohra.

## 4. *GOMPHONEMA* C.A AGARDH 1824

Cells usually epiphytic on the ends of dichotomously branched gelatinous stalks, sometimes sessile, sometimes solitary and free-floating, transversely asymmetric in both girdle and valve views, cuneate in girdle view, girdle smooth without intercalary band or septa; valve cuneate, clavate, lanceolate, or nearly straight, with one pole capitate or broader than the other, longitudinally symmetric; axial field narrow, straight, with a straight raphe and conspicuous central and polar nodules, striation strictly transverse or some time radial, striae composed of a single row of punctae; central area, sometime extended to the margins, with an asymmetrically placed dot, some time several dots, chromatophore a single, lobed plate, usually with a single pyrenoid; auxospores formed in pairs between two conjugated cells.

### i. *Gomphonema constrictum* (Ehrenberg) Grunow ( Fig.6)

#### **Morphology**

Cells 8-14 × 15-65 μm; valves typically clavate, without transverse constriction below the broad rounded apical pole, with attenuated basal pole; axial area narrow; central area broad and irregularly defined, with a dot on one side; transverse striations 10- 12 in 10 μm, radial, evidently punctate, alternately long and short in the middle of the valve

**Habitat:** Collected from Khashu river, Kurram river & Fresh spring water.

### ii. *Gomphonema geminatum* (Lyngbye) C.A. Agardh ( Fig.7)

**Morphology:** Cells 25-43 × 60-135 μm; valves biconstricted, with broad rounded sub truncate poles, the apex considerably larger than the base; axial area linear; central area rounded, with 2-4 dots in a longitudinal row; raphe terminally with dorsal hook; transverse striations, 9-10 in 10 μm generally radiate, medially alternately long and short, coarsely punctate.

**Habitat:** collected from Dhoab Kurram river&stream water.

iii. *Gomphonema acuminatum* (Eher) Rabenhorst (Fig.8)

**Morphology**

Valves generally cuneate, with a broad flat apex medially acutely topped and with a deep sub apical constriction, broadest near the apex and less so medially, with attenuated base, axial area linear narrow, central area large often indefinite with an isolated dot, transverse striations somewhat radial, length 47µm and breadth 10-14µm

**Habitat:** Scraped from surface on the sides of a freshwater of Kurram river touchi river & pond water.

iv. *Gomphonema gracile* (Ehrenberg) Grunow ( Fig.9)

**Morphology:** Cells 4-9×30-75 µm; valves linear-lanceolate, poles slightly cuneate and bluntly rounded, nearly symmetric; axial area wide, linear; central area small, quadrate rounded, with a dot on one side; transverse striations only slightly radial, indistinctly punctate, 9-17 in 10µm; gelatinous stalks long and largely dichotomously branched.

**Habitat:** collected from Small stream of Bannu & Kurram river

5. *CYMBELLA* C.A. AGARDH 1830

Cells solitary and free-floating or attached at the ends of gelatinous stalks or confined within little branched gelatinous tubes, with parallel sides in girdle view and smooth girdles, without intercalary bands; valves asymmetric, lunate or nearly elliptic or rhombic or naviculoid, dorsally convex, ventrally concave, straight or somewhat convex; axial field wide or narrow, nearer the vernal margin, with central area with or without dots; raphe curved, with well-defined nodules; transverse striations radiate, sometimes cross-lined; chromatophore a single expanded plate; auxospores formed in pairs between conjugating cells.

i. *Cymbella cistula* (Hemprich) Grunow (Fig.10)

**Morphology**

Cells 15-36×35-180 µm; valves strongly symmetric, naviculoid in shape with dorsal sides convex, ventral sides concave with a median expansion; raphe exocentric, broad, dorsally convex; axial area narrow, somewhat widened at the middle; transverse striations radiate, 6-9 in 10 µm, with punctae about 18-22 in 10µm; median ventral striations ending in two or more dots

**Habitat:** Scraped from surface of stone of Lohra nallah, Kurram river

ii. *Cymbella naviculiformis* Auerswald (Fig.11)

**Morphology**

Cells 9-16 ×30-50 µm; valves naviculoid, somewhat asymmetric, with evident constrictions below the rostrate- capitate poles; raphe slightly curved and exocentric; axial area narrow; central area large, circular; transverse striations radiate, 12-14 in 10 µm in the middle, becoming finer towards the poles.

**Habitat:** Scraped from surface of stone of Lohra nallah, Kashu river, Dhoab & Fresh spring water.

viii. *Cymbella prostrata* (Berkeley) Cleve (Fig.12)

**Morphology**

Cells 10-30 × 20-100 µm; valves quite asymmetric, semi elliptic, dorsally convex, ventrally straight with median expansion, poles broadly rounded; raphe straight with polar deviations ; axial area narrow; central area small, round, without isolated dots; transverse striations 7-10 in 10µm, radiate to parallel, with cross- lines about 20 in 10 µm.

**Habitat ;** collected from under Bridge stream, Touchi river & stream water.

iv. *Cymbella affinis* Kuetzing (Fig.13)

**Morphology**

Cells 7-16×20-70 µm valves quite asymmetric, semilanceolate to semi elliptic, convex dorsally, concave to straight ventrally, with rostrate, rounded poles; raphe excentric undulate toward the central nodule; axial area narrow, slight medially widened, with ventral median stria ending in an isolated dot; transverse striations 9-12 in 10 µm, radiate with cross lines, 24-30 in 10 µm.

**Habitat:**Collected from Lohra nallah, Kurram river & Dhoab.

v. *Cymbella cymbiformis* (Kuetzing) Brebisson (Fig.14)

**Morphology**

Cells 9-14 ×30-100 μm ; valves naviculoid, strongly curved, dorsally convex, ventrally nearly straight, with slight median expansion; raphe excentric, broad; axial area narrow, somewhat medially widened; transverse striations radiate, 8-10 in 10 μm, with cross- lines about 20 in 10 μm, median ventral stria ending in an isolated dot.

**Habitat:** collected from surface on the sides of a freshwater canal, Lohra nallah, Baran Dam & Dhoab.

**6. *Nitzschia vermicularis* (Kützing.) Hantzsch.**(Fig.15)

Slightly sigmoid with parallels sides in girdle view valves Slender somewhat naviculoid ends .

**DIMENSION:** length = 84.5μ, Breadth = 8μ, **No. of punctae** = 7-8

**Habitat:** Collected from a fresh water drain outside. Found as surface layer Tochi river intermingled with debris.

**ii. *Nitzschia palea* (Kützing.)W. Smith) .**(Fig.16)

**Morphology:** Frustules solitary girdle view linear with truncate ends, valve linear lanceolate with cuneate poles.striae obscure, carinal dots in the keel quite conspicuous.

**DIMENSION:** length = 35.5μ, Breadth = 5μ, **No.of punctae** = 10-14 in 10u

**Habitat:** Saline pool Kashhu river & Tarkhobi alged.

**7. *Pinnularia viridis* (Nitzsch)Ehrenberg.** (Fig.17)

**Morphology:** Valves linear to elliptic- linear with slightly convex sides and broadly rounded ends, axial area usually less than a forty of the cell diameter, widened centrally raphe complex somewhat undulate and with a one sided central pore, transverse striation medially lightly radial and polar convergent, crossed by a longitudinal band.

**Dimension:** Length= 129 μ, Breadth = 23 μ., **No of striae/10** = 8-9.

**Habitat:** collected from a small extensively weeded spring on the side of the virulent in the vicinity of Tarkhobi alged & Khalboi alged.

**8. *Surirella splendida* (Eher.) Kg.** ( Fig.18)

**Morphology:** Cells not iso polar, valves oval, pseudo raphe linear, narrow

**Dimension:** Length= 207 μ, Breadth = 66 μ, **No of costae/10u** =1.25-1.75

**Habitat:** Collected by towing in a Barran or Lohra alged.

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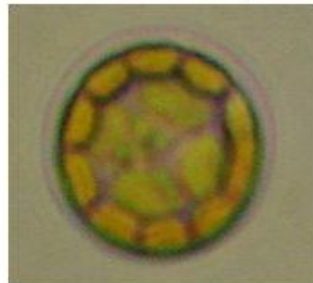
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**Plate No = 01 Cocconeis**



**Fig.1** - *Cocconeis plankentula*

**Plate No = 02 Cyclotella**



**Fig.2** *Cyclotella operculata*



**Fig.3** *Cyclotella meneghiniana*

**Plate No = 03**

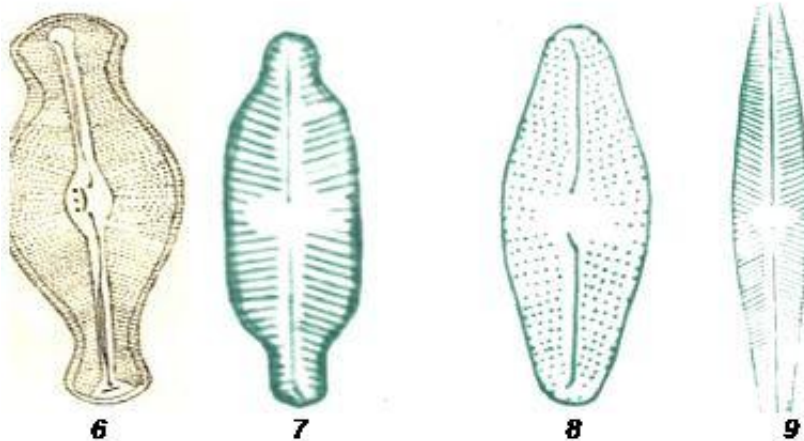


**Fig.4** *Gyrosigma attenuatum*



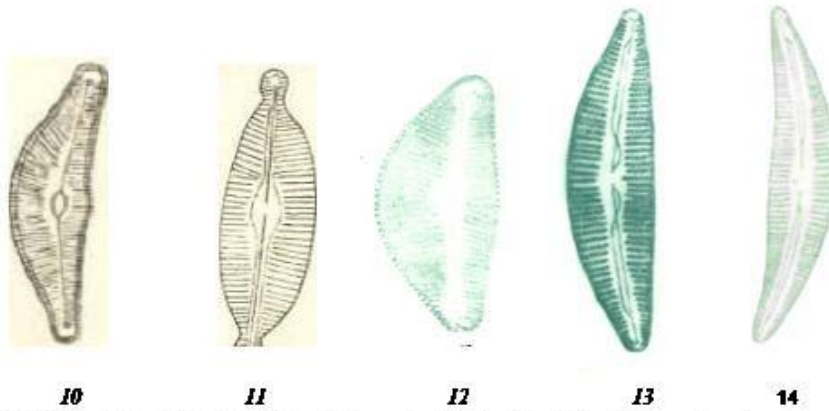
**Fig.5** *Gyrosigma acuminatum*

**Plate No = 04 Gomphonema**



**Fig.6** *Gomphonema constrictum*, **Fig.7** *Gomphonema gminatum*, **Fig.8** *Gomphonema acuminatum*,  
**Fig.9** *Gomphonema gracile*

**Plate No = 05 Cymbella**



**Fig.10. *Cymbella cistula*, Fig.11. *Cymbella naviciformis*, Fig.12. *Cymbella prostrata*,  
Fig.13. *Cymbella affinis*, Fig.14. *cymbella cymbiformis***

**Plate No = 07 Nitzschia**



**Fig.15. *Nitzschia ovumiculans***



**Fig.16. *Nitzschia palea***

**Plate No = 08 Pinnularia**



**Fig.17. *Pinnularia viridis***

**Plate No = 09 Surirella**



**Fig.18. *Surirella splendida***