

## DIVERSITY OF *PINNULARIA* (BACILLARIOPHYTA) IN THE NORTH-EASTERN AREAS OF PAKISTAN

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### Abstract

Eight species of the diatom genus *Pinnularia* (Ehrenberg) Ehrenberg (Pinnulariaceae, Bacillariales, Bacillariophyceae) were collected from various freshwater habitats at Gujranwala, Jhang, Kasur and Lahore districts of the Punjab Province of Pakistan and Chenari in Azad Kashmir during April to December 2004. All the collected species appeared in the vegetative state and occurred during winter and spring. They were taxonomically determined and described for the first time from these areas.

### Introduction

After detailed taxonomic studies on Bacillariophyta from areas now included in the north-eastern part of Pakistan (West & West, 1920; Carter, 1926; Abdul-Majeed, 1935; Salim & Khan, 1960) several attempts were made to report freshwater diatoms from the Punjab, Azad Kashmir (Masud-ul-Hasan & Zeb-un-Nisa, 1986; Masud-ul-Hasan & Batool, 1987; Masud-ul-Hasan & Yunus, 1989; Leghari MK *et al.*, 2003, 2004), Balochistan (Anjum & Hussain, 1983; Leghari SM *et al.*, 2006) and Sindh (Jahangir *et al.*, 2000, 2001; Leghari SM *et al.*, 2001, 2002, 2004, 2005a, b). But no detailed taxonomic study was carried out to investigate any diatomaceous genus. Therefore, a research program was started in March 2003 and a large collection of several genera of diatoms was made from freshwater habitats of various districts of the Punjab, certain areas of NWFP and Azad Kashmir, and taxonomically evaluated (Tariq-Ali *et al.*, 2006a, b, c). This is a continuation of that study.

### Materials and Methods

The collections were made from different freshwater habitats at Gujranwala, Jhang, Kasur and Lahore districts of the Punjab Province of Pakistan and Chenari in Azad Kashmir during April-December 2004. Collected material was preserved and taxonomically investigated as described earlier (Tariq-Ali *et al.*, 2006c). The specimens were identified with the help of authentic literature (Cleve, 1895; Østrup, 1908; Hustedt, 1930; Salim & Khan, 1960; Hirano, 1964; Starmach, 1964; Gerloff & Lüdemann, 1966; Schoeman, 1969; Cholnoky, 1970; Nizamuddin, 1984). Voucher specimens are kept in the Phycology & Phycochemistry Lab., MAH Qadri Biological Research Centre, University of Karachi, where this research work was conducted.

## Results and Discussion

Eight species of the diatom genus *Pinnularia* (family Pinnulariaceae, order Bacillariales, class Bacillariophyceae, phylum Bacillariophyta; *vide* Shameel, 2001) have been identified. All the collected species appeared in the vegetative state and no sexual reproduction was observed in them. They were found to occur only in winter and spring, which indicates their preference for low temperature. They were taxonomically described for the first time from their areas of collection. Their taxonomic enumerations are as follows:

### *Pinnularia* (Ehrenberg) Ehrenberg 1843: 45, *nom. cons.*

Frustules solitary and free floating, girdle linear, rectangular; valve linear, sometimes gibbous in the middle; ends broadly obtuse; raphe straight, central and polar nodules expanded, axial area broad; terminal fissures straight or sigmoid; striae or costae coarse, parallel or radiate with internal openings; chromatophores two, with pyrenoids. Its following eight species have been collected, which may be distinguished as follows:

- |   |                             |
|---|-----------------------------|
| 1. Valve up to 55 $\mu\text{m}$ long .....                    | 2                           |
| Valve more than 55 $\mu\text{m}$ long .....                   | 3                           |
| 2. Frustules up to 8 $\mu\text{m}$ broad .....                | 4                           |
| Frustules more than 8 $\mu\text{m}$ broad .....               | 5                           |
| 3. Valve more than 13 $\mu\text{m}$ broad .....               | 6                           |
| Valve up to 13 $\mu\text{m}$ broad .....                      | 7                           |
| 4. Frustules include 16 costae in 10 $\mu\text{m}$ area ..... | <i>P. appendiculata</i> (1) |
| Frustules include 14 costae in 10 $\mu\text{m}$ area .....    | <i>P. gracilens</i> (3)     |
| 5. Valve up to 11 $\mu\text{m}$ broad .....                   | <i>P. karelica</i> (4)      |
| Valve up to 13 $\mu\text{m}$ broad .....                      | <i>P. gibba</i> (2)         |
| 6. Frustules up to 25 $\mu\text{m}$ broad .....               | <i>P. nobilis</i> (6)       |
| Frustules up to 30 $\mu\text{m}$ broad .....                  | <i>P. major</i> (5)         |
| 7. Valve up to 65 $\mu\text{m}$ long .....                    | <i>P. stauroptera</i> (7)   |
| Valve up to 77 $\mu\text{m}$ long .....                       | <i>P. sudetica</i> (8)      |

#### 1. *P. appendiculata* (C. A. Agardh) Cleve 1895: 75

(Østrup, 1908: 271; Hirano, 1964: 193; Starmach, 1964: 360; Schoeman, 1969: 61; Biswas 1975: 583, Nizamuddin, 1984: 91)

Fig. 1

**Synonymies:** *Navicula appendiculata* var. *irrorata* Grunow 1880, *Pinnularia silvatica* J. B. Petersen 1935: *Pinnularia irrorata* (Grunow 1880) Hustedt 1939.

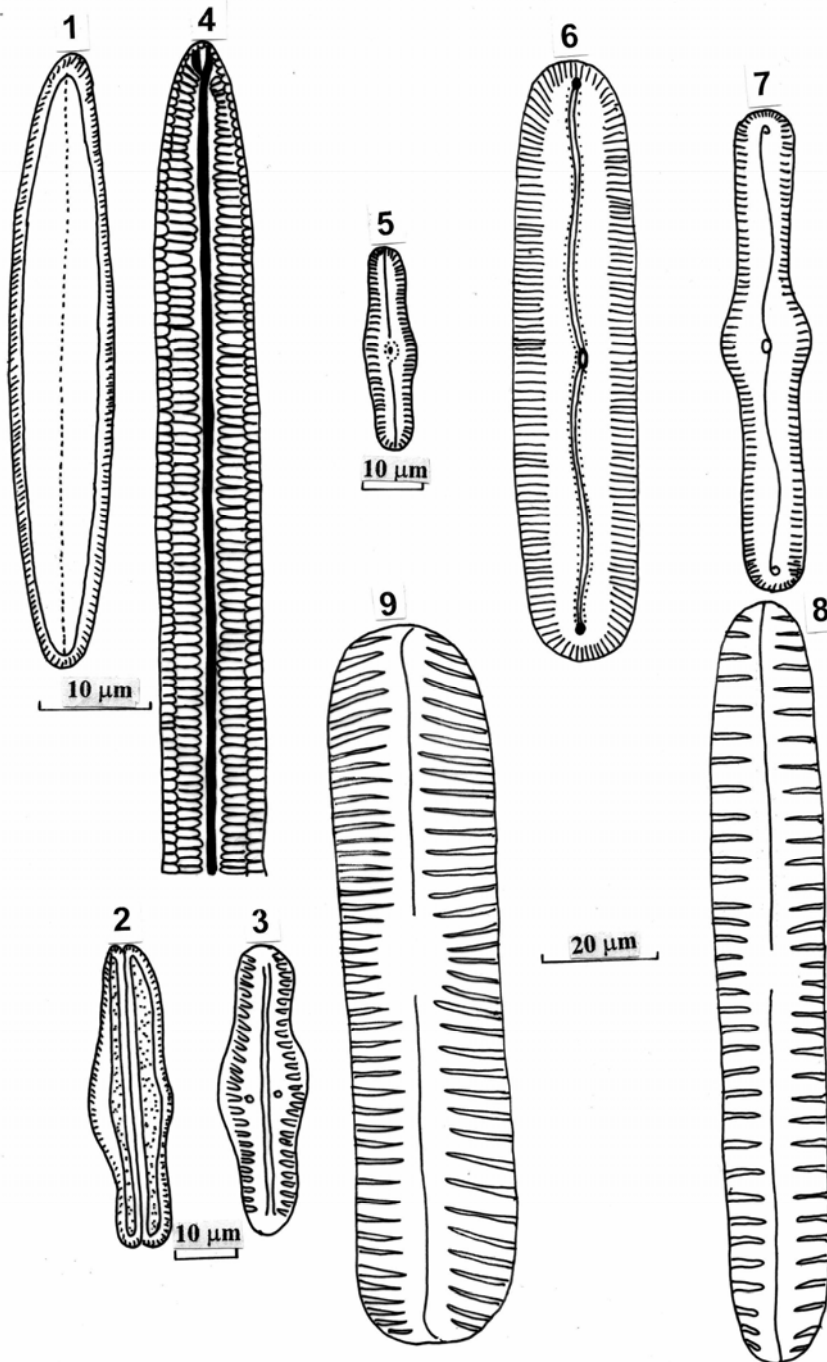
**General characters:** Valve 30-37  $\mu\text{m}$  in length and 5-6  $\mu\text{m}$  in breadth; 10  $\mu\text{m}$  area includes 16 costae.

**Cytological features:** Chromatophores two, with pyrenoids.

**Locality:** Gujranwala District: Dera Ahmed Shah (11-12-2004).

**Geographical distribution:** Europe, Libya, Poland, Faeröes (Denmark).

**Remarks:** The specimens were obtained during winter from a roadside pond.



Figs. 1-8. Species of the genus *Pinnularia*: 1. *P. appendiculata*, 2. *P. gibba*: lateral view, 3. *P. gibba*: front view, 4. *P. gracilens*, 5. *P. karelica*, 6. *P. major*, 7. *P. nobilis*, 8. *P. stauroptera*, 9. *P. sudetica*.

**2. *P. gibba* Ehrenberg 1841: 384**

(Cleve, 1895: 82; Hustedt, 1930: 327; Hirano, 1964: 194; Starmach, 1964: 374; Schoeman, 1969: 63; Cholnoky, 1970: 32; Nizamuddin, 1984: 91; Jahangir *et al.*, 2000: 1967; Leghari & Leghari, 2002: 183; Leghari MK *et al.*, 2004: 42)

Figs. 2 & 3

**General characters:** Valve linear, gradually tapering to the subcapitate ends; raphe filiform with curved terminal fissures; axial area linear, widened around the central nodule; striae divergent in the middle and convergent at ends; length of frustules 75-77  $\mu\text{m}$  and breadth 10-13  $\mu\text{m}$ ; striae 10-11 within 10  $\mu\text{m}$ .

**Cytological features:** Chromatophores two with pyrenoids.

**Locality:** Lahore District: Badshahi Mosque (9-4-2004).

**Geographical distribution:** Pakistan, Libya, Poland.

**Remarks:** The material was collected during spring from fountain water.

**3. *P. gracilens* J. Frenganlli**

(Inam *et al.*, 1986: 2)

Fig. 4

**General characters:** Length 50-52  $\mu\text{m}$  and breadth 7-8  $\mu\text{m}$ ; striae 14 within 10  $\mu\text{m}$ .

**Cytological features:** Chromatophores two, with pyrenoids.

**Locality:** Lahore District: Zoological Garden (3-5-2004).

**Geographical distribution:** Patagonia.

**Remarks:** The specimens were obtained during spring from fountain water.

**4. *P. karelica* Cleve in Hustedt 1930: 332**

(Hirano, 1964: 194; Starmach, 1964: 363)

Fig. 5

**General characters:** Frustules solitary and free floating; girdle linear, rectangular; valve gibbous in the middle, ends broadly obtuse; striae costate, crossed by a band, that is more or less distinct; cell length 45-46  $\mu\text{m}$  and breadth 10-11  $\mu\text{m}$ .

**Cytological features:** Chromatophores, two with pyrenoids.

**Locality:** Lahore District: Mahmood-Booti (23-4-2004).

**Geographical distribution:** Iran, Poland.

**Remarks:** The material was collected during spring from a pond.

**5. *P. major* (Kützing) Cleve**

(Østrup, 1908: 274; Hirano, 1964: 195; Starmach, 1964: 382; Gerloff & Lüdemann, 1966: 107; Jahangir *et al.*, 2000: 1967; Biswas 1975: 583)

Fig. 6

**General characters:** Frustules solitary, valve linear, ends broadly obtuse; raphe flexuose; central and polar nodules expanded; striae distinct; cell length 110-158  $\mu\text{m}$  and breadth 17-29  $\mu\text{m}$ .

**Cytological features:** Chromatophores two.

**Locality:** Azad Kashmir: Chenari (28-4-2004).

**Geographical distribution:** Afghanistan, Poland, Faeröes (Denmark).

**Remarks:** The specimens were obtained during spring from a stagnant pool.

**6. *P. nobilis* Ehrenberg 1843: 384**

(Østrup, 1908: 275; Starmach, 1964: 386; Nizamuddin, 1984: 91;

Jahangir *et al.*, 2000: 1967)

Fig. 7

**General characters:** Valve linear, gradually tapering to the sub-capitate ends; raphe filiform, with curved, terminal fissures; striae divergent in the middle and convergent at the ends; cell 140-143 µm long and 24-25 µm broad.

**Cytological features:** Chromatophores two, with pyrenoids.

**Locality:** Jhang District: Trimmu Head Work (30-12-2004).

**Geographical distribution:** Europe, Libya, Poland, Faeröes (Denmark).

**Remarks:** The material was collected during winter from stagnant ponds.

**7. *P. stauroptera* (Grunow) Rabenhorst**

(Salim & Khan, 1960: 36; Hirano, 1964: 195; Starmach, 1964: 377, Biswas 1975: 583)

Fig. 8

**Basionym:** *Navicula stauroptera* Grunow.

**General characters:** Valves 52-65 µm in length and 8.5-9.5 µm in breadth. **Cytological features:** Chromatophores two, with pyrenoids.

**Locality:** Kasur District: Kahna Now Village (22-12-04).

**Geographical distribution:** Europe, Afghanistan, Pakistan (Peshawar), Poland.

**Remarks:** The specimens were obtained during winter from ponds at a village.

**8. *P. sudetica* (Hilse) Hilse 1861**

(Hirano, 1964: 196; Starmach, 1964: 385, Biswas 1975: 587)

Fig. 9

**Synonymy:** *P. viridis* var. *sudetica* (Hilse 1861) Husted.

**General characters:** Valves 52-55 µm in length and 10.8-13.0 µm in breadth.

**Cytological features:** Chromatophores two, with pyrenoids.

**Locality:** Kasur District: Kahna Now Village (22-12-2004).

**Geographical distribution:** Iran, Poland.

**Remarks:** The material was collected during winter from ponds at a village.

**References**

- Abdul-Majeed, M. 1935. *Freshwater Algae of the Punjab. I. Bacillariophyta (Diatomeae)*. Punj. Univ. Publ., Lahore, 45 pp.
- Anjum, G. and F. Hussain. 1983. The genera *Cymbella* and *Navicula* from Quetta-Pishin Valley, Balochistan. *J. Sci. Tech.*, 7: 1-7.
- Biswas, S. 1975. Freshwater algae of New Borough Warren Dune Area. *Nova Hedw.*, 24: 561-589.
- Carter, N. 1926. Freshwater algae from India. *Rec. Bot. Surv. Ind.*, 9: 263-302.
- Cholnoky, B.J. 1970. Hydrobiologische Untersuchungen in Transvaal-III. Die Fischteiche von Marble Hall. *Bot. Mar.*, 13: 5-44.

- Cleve, P.T. 1894. Synopsis of the naviculoid diatoms-I. *Kongl. Svensk. Vet-Akad. Handl.*, 26: 1-194.
- Gerloff, J. and D. Lüdemann. 1966. *Leitfaden der Trink- und Brauch-wasserbiologie*. 2<sup>nd</sup> ed., Gustav Fisch. Verlag, Stuttgart, 360 pp.
- Hustedt, F. 1930. Bacillariophyta. In: *Süßwasserflora*. (Ed.): Pascher. 10: 1-466.
- Hirano, M. 1964. Freshwater algae of Afghanistan. In: *Plant of West Pakistan and Afghanistan*. (Ed.): S. Kitamura, Kyoto, Univ., Japan, p. 167-245.
- Inam, B., K. Nazir and M.K. Leghari. 1986. Some diatoms from Islamabad-I. *J. Sci. Technol.*, 10: 1-3.
- Jahangir, T.M., M.Y. Khuhawar, S.M. Leghari, W.A. Balouch, A.A. Leghari and A. Leghari. 2000. Some studies on water quality and biological life at Kinjhar and Haleji lakes of district Thatta, Sindh, Pakistan. *Pak. J. Biol. Sci.*, 3: 1965-1972.
- Jahangir, T.M., M.Y. Khuhawar, S.M. Leghari and A. Leghari. 2001. Physico-chemical and biological study of Mangho Pir eutermal springs Karachi, Sindh, Pakistan. *Online J. Biol. Sci.*, 1: 636-639.
- Leghari, M.K. and M.Y. Leghari. 2002. Comparative ecological study of phytoplankton of Bakar and Phoosna lakes-Pakistan. *Pak. J. Sci. Ind. Res.*, 45: 182-190.
- Leghari, M.K., M.Y. Leghari, M. Shah and S.N. Arbani. 2003. Ecological study of algal flora of Wah Garden, district Attock, Pakistan. *Pak. J. Bot.*, 35: 705-716.
- Leghari, M.K., M.Y. Leghari and S.M. Leghari. 2004. Water chemistry and its relation with algae of Rawal Dam, Islamabad and Wah Garden, district Attock. *Sindh Univ. Res. J. (Sci. Ser.)*, 36: 29-48.
- Leghari, S.M., T.M. Jahangir, M.Y. Khuhawar and A. Leghari. 2001. Physico-chemical and biological study of Dhabeji spring, Malir, Karachi, Sindh, Pakistan. *Online J. Biol. Sci.*, 1: 623-627.
- Leghari, S.M., T.M. Jahangir, M.Y. Khuhawar and A. Leghari. 2002. Study on the natural springs at Clifton, Karachi, Sindh, Pakistan. *Proc. Pak. Cong. Zool.*, 22: 125-131.
- Leghari, S.M., T.M. Jahangir, M.Y. Khuhawar and A. Leghari. 2004. Some studies on Nang spring and torrents of Khar Centre, Khirthar National Park, Gudap area, Malir, Karachi, Sindh, Pakistan. *Sindh Univ. Res. J. (Sci. Ser.)*, 36: 25-30.
- Leghari, S.M., M.Y. Khuhawar, T.M. Jahangir and A. Leghari. 2005a. Limnological study of natural springs at Gharo Creek, district Thatta, Sindh, Pakistan. *Int. J. Phycol. Phycochem.*, 1: 37-42.
- Leghari, S.M., M.Y. Khuhawar, T.M. Jahangir and A. Leghari. 2005b. Limnological study of Pir Bukhari (Karsaz) and Manghopir warm springs, Karachi, Sindh, Pakistan. *Int. J. Phycol. Phycochem.*, 1: 151-158.
- Leghari, S.M., M.Y. Leghari, M.A. Mahar, M.Y. Khuhawar and T.M. Jahangir. 2006. Limnological study of Hanna Lakes and Urak Spring of Quetta, Balochistan, Pakistan. *Int. J. Phycol. Phycochem.*, 2: 33-38.
- Masud-ul-Hasan and I. Batool. 1987. A taxonomic study of some freshwater algae from Attock and Sargodha districts. *Biologia*, 33: 345-366.
- Masud-ul-Hasan and A. Yunus. 1989. An addition to the algal flora of Lahore. *Biologia*, 35: 99-131.
- Masud-ul-Hasan and Zeb-un-Nisa. 1986. Taxonomic studies of some freshwater algae from Azad Jammu and Kashmir. *Biologia*, 32: 229-256.
- Nizamuddin, M. 1984. *Diatoms of Libya*. Dept. of Botany, Univ. of Al-Fateh, Tripoli, 144 pp.
- Østrup, E. 1908. Freshwater diatoms. In: *Botany of the Faeröes Based Upon Danish Investigations*. (Ed.): E. Warming. Gyldendalske Boghandel, Nordisk Forlag, Copenhagen, p. 260-290.
- Salim, K.M. and M.H. Khan. 1960. *The Diatomales: The Fresh Water Diatoms of Peshawar Valley*. Dept. of Botany, Peshawar Univ., Peshawar, 66 pp. + 11 pls.
- Schoeman, F.R. 1969. Diatoms from the Orange Free State (South Africa) and Lesotho. No. 2, *Revist. Biol.*, 7: 35-74.

- Shameel, M. 2001. An approach to the classification of algae in the new millennium. *Pak. J. Mar. Biol.*, 7: 233-250.
- Starmach, K. 1964. *Flora Slodkowodna Polski. 6. Chrysophyta II. Bacillariophyceae - Okrzemki*. Panstwowe Wydawnictwo Naukowe, 610 pp.
- Tariq-Ali, S., A. Zarina, Masud-ul-Hasan and M. Shameel. 2006a. Taxonomic studies on *Cymbella* (Bacillariophyta) from Punjab and Azad Kashmir. *Pak. J. Bot.*, 38: 161-167.
- Tariq-Ali, S., A. Zarina, Masud-ul-Hasan and M. Shameel. 2006b. Taxonomic studies on *Navicula* (Bacillariophyta) from certain areas of the Punjab, Pakistan. *Pak. J. Bot.*, 38: 435-441.
- Tariq-Ali, S., A. Zarina, Masud-ul-Hasan and M. Shameel. 2006c. Taxonomic studies on *Nitzschia* (Bacillariophyta) from Kasur and Lahore districts of Pakistan. *Proc. Pak. Acad. Sci.*, 43: 151-155.
- West, G. S. and W. West. 1902. A contribution to the freshwater algae of Ceylon. *Trans. Linn. Soc. Bot.*, ser. 2, 6: 123-215.

(Received for publication 25 April 2006)