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TAXONOMIC STUDIES ON *NAVICULA* (BACILLARIOPHYTA) FROM CERTAIN AREAS OF THE PUNJAB, PAKISTAN

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Abstract

Nine species of the diatom genus *Navicula* Bory de Saint-Vincent (Naviculaceae, Bacillariales, Bacillariophyceae) were collected from various freshwater habitats at Gujranwala, Kasur, Lahore and Sheikhupura districts of the Punjab Province of Pakistan during April and December 2004. They were taxonomically determined and have been described for the first time from these areas.

Introduction

Salim & Khan (1960) carried out a composite taxonomic investigation of the diatom algal flora of Peshawar Valley (N. W. F. P.) of Pakistan. After that, a few species of diatoms were described from Punjab, N. W. F. P. and Azad Kashmir (Masud-ul-Hasan & Zeb-un-Nisa, 1986; Masud-ul-Hasan & Batool, 1987; Masud-ul-Hasan & Yunus, 1989; Leghari MK *et al.*, 1991, 1995, 2002, 2003, 2004; Sultana *et al.*, 1991; Leghari & Sultana, 1993). Several attempts have also been made to report some diatom species from Sindh Province of Pakistan (Daudpota & Leghari, 1993; Jahangir *et al.*, 2000, 2001; Leghari SM *et al.*, 2001, 2002, 2004, 2005a, b; Leghari & Leghari, 2002). But no detailed study was made on taxonomy of the Bacillariophyta of the country. Therefore, a research program was started in March 2003 (Tariq-Ali *et al.*, 2005), and a large collection of diatoms was made from freshwater habitats of different districts of the Punjab, certain areas of N. W. F. P. and Azad Kashmir. As a result of that ten species of *Cymbella* C. A. Agardh were taxonomically described (Tariq-Ali *et al.*, 2006). This is a continuation of that research program in which taxonomic description of the collected species of the genus *Navicula* Bory de Saint-Vincent have been presented.

Materials and Methods

Algal specimens were collected from different freshwater habitats of Gujranwala, Kasur, Lahore and Sheikhupura districts of the Punjab Province of Pakistan during April and December 2004. Collected material was taxonomically investigated as described previously (Tariq-Ali *et al.*, 2005, 2006). The algal specimens were identified with the help of authentic literature (Østrup, 1908; Salim & Khan, 1960; Starmach, 1964; Gerloff & Lüdemann, 1966; Nizamuddin, 1984). The voucher specimens are kept in the Phycology and Phycochemistry Lab., MAH Qadri Biological Research Centre, University of Karachi, where this research work was conducted.

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Results and Discussion

Nine species belonging to the diatom algal genus *Navicula* (Naviculaceae, Bacillariales, Bacillariophyceae; *fide* Shameel, 2001), were identified and taxonomically described for the first time from their areas of collection in Pakistan. Their taxonomic enumerations are as follows:

***Navicula* Bory de Saint-Vincent 1822: 128, *emend.* Cleve 1894**

Frustules free floating, solitary or in colonies; girdle straight, rectangular; valves linear, lanceolate or fusiform; ends capitate, rounded or rostrate; raphe straight with central and polar nodules; striae or costae transverse, parallel or radiate; axial area narrow, linear; chromatophores two, laminate, lie on both sides of the valve with a bridge like connection in the middle, sometimes split up into numerous small rounded granules. In the present collection following species could be collected, which are distinguished as follows:

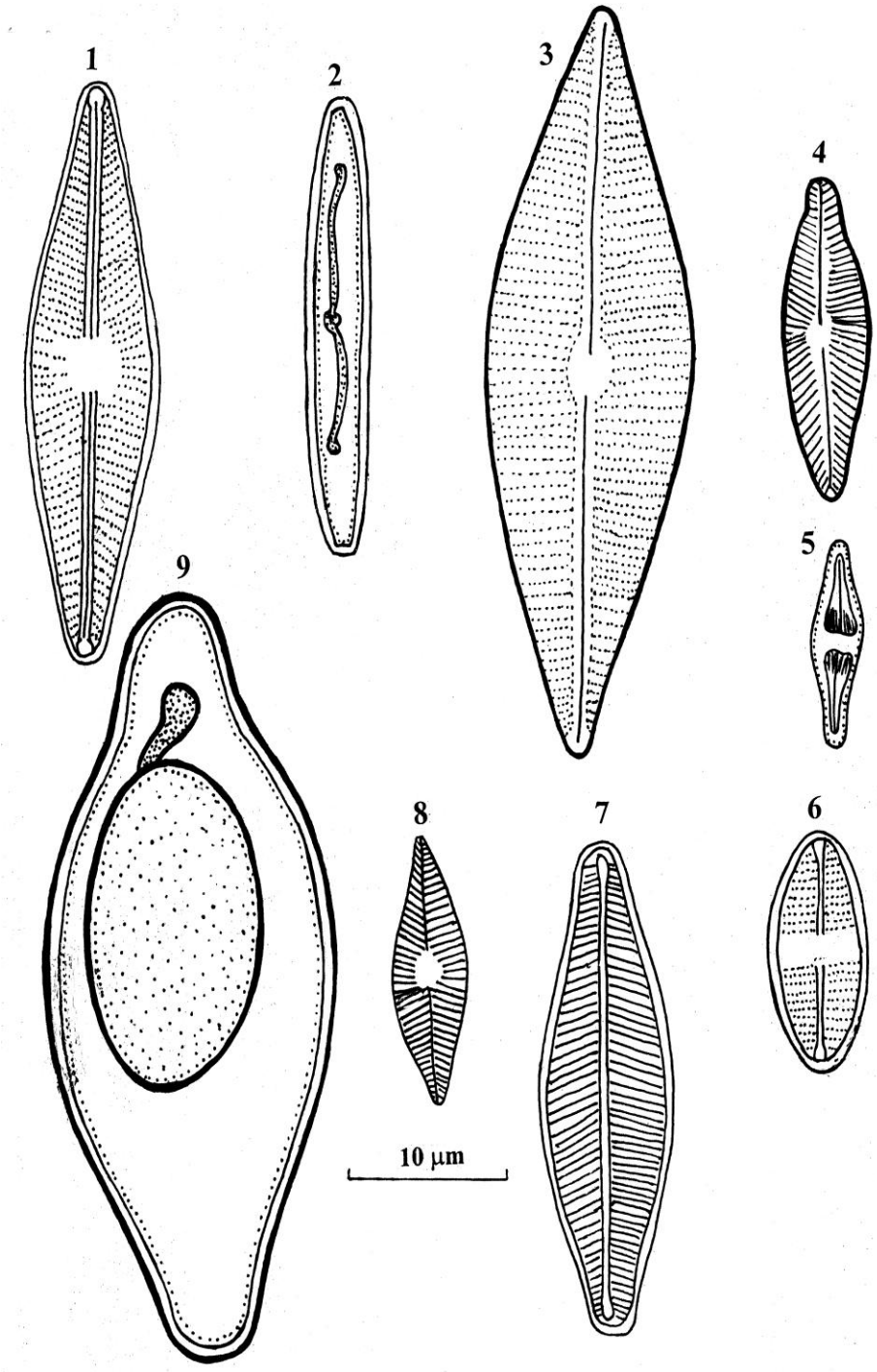
1. Valve more than 100 µm long ……………………………………………….. 2
   Valve less than 100 µm long ………………………………………..……….. 3
2. Frustule elongated ..……………………………………..……. *N. cuspidata* (3)
   Frustule otherwise ……………………………..………... *N. rhynchocephala* (8)
3. Valve up to 8 µm broad …………..…………………… ....…………………….. 4
   Vave more than 8 µm broad ………………………………......…………………. 5
4. Frustule up to 14 µm long ……………………………....…….. *N. knysnesis* (5)
   Frustule more than 14 µm long ……………………...……..……………...……. 6
5. Valve rhomboidal ………………………………..…..…….......... *N. mutica* (6)
   Valve otherwise …………………………………………….……..……..……….. 7
6. Frustule up to 24 µm long …………………………….…..…… *N. cryptocephala* (4)
   Frustule up to 48 µm long ….………………………….…..………….. *N. cari* (2)
7. Valve more than 48 µm long ..…………………….…….....…. *N. ammophila* (1)
   Valve less than 48 µm long …………………..……..…....………………….. 8
8. Frustule narrow ……………………………………….…………...…. *N. radiosa* (7)
   Frustule broad …………………..………………………….……..….. *N. viridula* (9)

1. *N. ammophila* Grunow 1862: 149
(Fig. 1)

General characters: Valves 49-56 µm in length and 15-16 µm in breadth; chromatophores two, laminate.
Locality: Gujranwala District: Gujranwala (11-12-2004).
Geographical distribution: Afghanistan, Myanmar, Greece.
Remarks: The specimens were collected from a roadside pond in winter. Reproduction was not observed. The material was collected in the vegetative form.

2. *N. cari* Ehrenberg 1836
(Fig. 2)

Reference: Starmach, 1964: 335.
General characters: Valves 40-48 µm in length and 4-6 µm in breadth; ends rounded; chromatophores two, laminate.
Locality: Gujranwala District: Khori, Kamonke (11-12-2004).
Geographical distribution: Afghanistan: Jalalabad, Bwima; Java and Europe: Greece, Poland.
Remarks: The material was obtained from a roadside pond during winter. The specimens were collected in vegetative form only and reproduction was not seen.



Figs. 1-9. Species of *Navicula* from Pakistan: 1. *N. ammophila*, 2. *N. cari*, 3. *N. cuspidata*, 4. *N. cryptocephala*, 5. *N. knysnesis*, 6. *N. mutica*, 7. *N. radiosa*, 8. *N. rhynchocephala*, 9. *N. viridula*.

3. *N. cuspidata* Kützing
(Fig. 3)

References: Salim & Khan, 1960: 29; Starmach, 1964: 295; Gerloff & Lüdemann, 1966: 107.
General characters: Valves elongated, rhombic-lanceolate; ends produced and rounded; axial area linear, median line distinct; cell length 143-145 μm and breadth 34-36 μm; chromatophores two, laminate.
Locality: Lahore District: between Mureedke and Narang Mundi (20-9-2004).
Geographical distribution: Poland, India, Pakistan: Peshawar.
Remarks: The specimens were collected from paddy fields in between Mureedke and Narang Mundi during autum. Reproduction was not observed and the material was obtained in vegetative form only.

4. *N. cryptocephala* Kützing 1844: 95
(Fig. 4)

References: Østrup, 1908: 268; Starmarch, 1964: 330; Gerloff & Lüdemann 1966: 107; Nizamuddin, 1984: 72; Inam *et al.*, 1986: 2; Leghari MK *et al.*, 1991: 11, 2002: 78, 2004: 42; Jahangir *et al.*, 2000: 1967; Leghari & Leghari, 2002: 185.
General characters: Valves 18-24 μm in length and 5-8 μm in breadth; central area small and distinct; chromatophores two, laminate.
Localities: Gujranwala District: Raja Village (27-12-2004); Kasur District: Kasur (28-12-2004).
Geographical distribution: Afghanistan: Chatrass, Voma, Kabul swamp; Japan, Libya, Poland, Faeröes (Denmark).
Remarks: Although this species resembles *N. ammophila* but its valves are broader than that. The material was obtained from a roadside pond of Raja Village from Gujranwala and from stagnant pond of Kasur during winter. The specimens were collected in vegetative form only and reproduction was not seen in them.

5. *N. knysnesis* Meister
(Fig. 5)

General characters: Valve 14 μm in length and 3 μm in breadth; striae only visible at the center; chromatophores two, laminate, lie on both sides of the valve.
Locality: Lahore District: Badshahi Masjid (24-4-2004).
Geographical distribution: U. S. A.
Remarks: The specimens were collected from fountain of Badshahi Mosque at Lahore during summer. Reproduction was not found and the material was obtained in the vegetative form only.

6. *N . mutica* Kützing 1844: 93
(Fig. 6)

References: Salim & Khan, 1960: 29; Gerloff & Lüdemann, 1966: 107; Nizamuddin, 1984: 77.
General characters: Frustules solitary, free floating; girdle linear, rectangular; valve rhomboidal, lanceolate, obtuse at the produced ends; raphe straight; cell length 18-25 μm and breadth 8-10 μm; 17-19 striae / 10 μm; chromatophores two, green.
Localities: Sheikhupura District: between Mureedke and Narang Mundi (29-9-2004); Lahore District: Jinnah Garden (23-9-2004).

Geographical distribution: India: Amritsar, Jullundar; Pakistan: Peshawar, Lahore, Gujranwala; Libya.
Remarks: The specimens were collected from paddy fields between Mureedke and Narang Mundi and from fountain of Jinnah Garden. Reproduction was not observed, and the specimens were collected in vegetative form.

7. *N. radiosa* Kützing 1844: 91
(Fig. 7)

References: Østrup, 1908: 269; Salim & Khan, 1960: 31; Starmach, 1964: 336; Gerloff & Lüdemann, 1966: 107; Nizamuddin, 1984: 79; Masud-ul-Hasan & Zeb-un-Nisa 1987: 359; Jahangir *et al.*, 2000: 1967; Leghari & Leghari, 2002: 185; Leghari MK *et al.*, 2002: 78, 2004: 42.
Synonym: *Navicula imbricata* Bock 1962.
General characters: Frustules solitary; valve narrow, lanceolate, gradually tapering from the middle to the acute ends; axial area indistinct, central area somewhat rounded; striae nearly radiate; cell length 40-44 μm, breadth 8-10 μm; striae 12-15 within 10 μm; two laminate chromatophores.
Localities: Lahore District: Badshahi Masjid (3-5-2004), Bund Road (5-5-2004); Gujranwala District: Mahay, Kamonke (11-12-2004).
Geographical distribution: Pakistan: Peshawar, Lahore, Gujranwala, Attock; Libya, Poland, Faeröes (Denmark).
Remarks: The material was obtained from fountain of Badshahi Mosque, a pond near Bund Road Lahore during summer and a roadside pond of Mahay, Kamonke in winter. Reproduction was not observed. The specimens were collected in vegetative form only.

8. *N. rhynchocephala* Kützing 1844: 152
(Fig. 8)

References: Østrup, 1908: 268; Starmach, 1964: 331; Gerloff & Lüdemann, 1966: 107; Jahangir *et al.*, 2000: 1967.
General characters: Valves 88-100 μm long; 13 costae / 10 μm; two laminate chromatophores.
Locality: Gujranwala District: Singh Village, Tehsil Kamonke (11-12-04).
Geographical distribution: Afghanistan: Auristan, Pushuki, Kunduz, Kabul River, Jalalabad; Poland, Faeröes (Denmark); Greece; Siberia; Japan; Java; Tibet.
Remarks: The specimens were collected from a roadside pond of Singh Village during winter. The material was obtained in vegetative form, and their reproduction was not seen.

9. *N. viridula* (Kützing) Ehrenberg 1838
(Fig. 9)

References: Østrup, 1908: 268; Salim & Khan, 1960: 30; Starmach, 1964: 332; Nizamuddin, 1984: 80; Masud-ul-Hasan & Zeb-un-Nisa, 1987: 359; Leghari MK *et al.*, 1991: 11; Jahangir *et al.*, 2000: 1967, 2001: 637; Leghari SM *et al.*, 2005: 156.
General characters: Frustules solitary; valve broadly lanceolate with attenuated, subrostrate ends; striae radiate, axial area narrow, central area rounded; cell length 46.0-47.5 μm and breadth 9.0-10.2 μm; chromatophores two, laminate.
Locality: Gujranwala District: Chendaly (11-12-2004).

Geographical distribution: Pakistan: Peshawar; Attock, Lahore; Libya, Poland, Faeröes (Denmark).

Remarks: The material was obtained from ponds of Chendaly during winter. Reproduction was not observed and the specimens were collected in vegetative form only.

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