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DIVERSITY OF THE GENERA OF PENNATE DIATOMS IN THE PUNJAB

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Abstract

Twenty nine genera of algae belonging to 15 families of the phylum Bacillarophycota were collected during December 2003 and July 2006 from different freshwater habitats in various districts of the Punjab Province of Pakistan. Among them family Pinnulariaceae with 19 species was most commonly found (25.33 %), next to it were the families Cymbellaceae (13.33 %), Naviculaceae (13.33 %) and Nitzschaceae (12 %) with 9 or 10 species each. The genera *Cymbella* with 10 species (13.33 %), *Nitzschia* with 9 species (12 %), *Navicula* and *Pinnularia* with 8 species each (10.66 %) occurred most commonly. About 64 % of diatoms were found as epiphytes, 22.66 % as planktic and epiphytic both, and 13.33 % as pure planktic individuals. Greatest proportion of collections (89.33 %) were made from Lahore City and its neighbouring areas, which was followed by the districts of Gujranwala (24 %) and Kasur (20 %). Most of the diatoms were collected in winter (42.66 %), smallest number of them were found in autumn (10.66 %), while in rest of the two seasons they occurred in almost equal proportions (25.33 & 26.66 %).

Introduction

Carter (1926) described for the first time 49 new species of freshwater diatoms from the region now included in Pakistan. Later on Abdul-Majeed (1935) gave an account of 62 diatoms of the undivided Punjab. A detailed investigation on the taxonomy of 102 species belonging to 25 genera of freshwater diatoms of Peshawar Valley (N. W. F. P.) was carried out by Salim & Khan (1960). Apart from that several attempts were also made to describe marine diatoms from the coastal waters of Karachi (Salim, 1954, 1963; Salim & Iqbal, 1964; Saifullah & Moazzam, 1978) and other areas of Sindh (Ghazala *et al.*, 2006).

Later on some species of freshwater diatoms were further reported from Punjab (Masud-ul-Hasan & Batool, 1987; Masud-ul-Hasan & Yunus, 1989), Islamabad (Inam *et al.*, 1986; Leghari *et al*., 2002, 2004), N. W. F. P. (Leghari *et al.*, 1991, 1995, 2003), Balochistan (Anjum & Hussain, 1983; Leghari *et al.*, 2006), Sindh (Jahangir *et al*., 2000; Leghari *et al*., 2001, 2005a-c) and Azad Kashmir (Masud-ul-Hasan & Zeb-un-Nisa, 1986). But no composite study was carried out on the diversity of Bacillarophycota from any area of the country. Therefore, a wide range research program was started in March 2003 to make a detailed investigation on the diversity of this phylum and a large scale collection of diatoms was carried out from freshwater habitats of various districts of the Punjab.

Materials and Methods

Algal collections were made during December 2003 and July 2006 from various areas of the districts of Gujranwala, Jhang, Kasur, Lahore, Sargodha, Sheikhupura and Sialkot in the province of the Punjab. Planktic and epiphytic algae were collected from various freshwater habitats *e.g.*, rain pools, road-side ponds, fountain-water tanks, permanent water reservoirs, rivers, rice fields, canals and irrigation channels during different seasons of the year. The specimens were collected using phytoplankton net of 5-10 µm mesh. Water samples obtained by Nansen bottle from 3-4 m depth were filtered to separate planktic individuals. Epiphytic individuals were obtained by crushing the twigs, leaves and other parts of the collected vegetation. The algal specimens collected from different sources were centrifuged and preserved in plastic bottles containing 3 % formalin solution and brought to Karachi.

In the laboratory at Karachi the specimens were picked up using a dropper from the samples collected from various sources, placed in 10 % glycerin mounts and studied under Zeiss Stereomicroscope. Identification of the specimens down to the species level was carried out with the help of authentic literature (Cleve, 1894, 1895; Østrup, 1908; Hustedt, 1930; Salim & Khan, 1960; Giffen, 1963, 1966, 1970; Starmach, 1964; Nizamuddin, 1984).

Results and Discussion

Twenty-nine genera containing 75 speices of planktic and epiphytic algae with solitary or colonial organisations belonging to one phylum, one class, one order and 15 families have been collected from various freshwater habitats. The collected specimens were investigated cytologically and morphologically, and on the basis of such characters they were taxonomically determined up to species level, but most of them appeared to be new records from these areas when compared with the previous observations (Inam *et al*., 1986, Sultana *et al*., 1991, Leghari *et al*., 1995, 2002, 2004, Husna *et al*., 2006, 2007, Shahida *et al*., 2006). The collected genera have been systematically arranged according to the newly proposed classification (Shameel, 2001) with new taxonomic nomenclature suggested by Shameel (2008) has been used (Tables 1-3).

1. Taxonomic diversity: The order Bacillarales was represented in this study by 15 families, among them Pinnulariaceae with 19 species was most commonly found (25.33 %). Next to it were the families Cymbellaceae (13.33 %), Naviculaceae (13.33 %) and Nitzschaceae (12.0 %) with 9 or 10 species (Table 1). At other localities also these families were found to be more prevalent than others (Cleve, 1894, 1895; Huber-Pestalozzi, 1942; Giffen, 1966, 1970). The families Bacillaraceae, Gomphonemaceae, Swirellaceae, Tabellaraceae, Thallassiosiraceae, Epithemaceae and Eunotaceae with 1 or 2 species were most poorly represented. While at the generic level, *Cymbella* with 10 species (13.33 %), *Nitzschia* with 9 species (12.0 %), *Navicula* and *Pinnularia* with 8 species each (10.66 %) occurred most commonly. *Bacillaria, Anomoeoneis, Fragilaria, Fragilariforma, Frustulia, Luticola, Mastogloia, Neidium, Stauroneis, Tabellaria, Cyclotella, Epithemia, Rhopalodia* and *Eunotia* with one species each, were very poorly represented genera in the present collection. Usually they were observed to be of rare occurrence in other studies (Thomson, 1938; Whitford, 1943; Prescott & Vinyard, 1965).

2. Habitat diversity: The collected genera were found to occur in three different ways of living (Table I): (1) only in planktic condition, (2) only in epiphytic habitat, (3) both in planktic and epiphytic conditions (sometimes free-floating, sometimes attached with other algae and water plants). No epilithic, epipsammic or epipelic alga was collected, none of them was found simultaneously in planktic and benthic conditions (Table 1). Almost 64 % of them occurred as epiphytes, 22.66 % as planktic and epiphytic both, and 13.33 % as pure planktic individuals. There are several families such as Achnanthaceae, Bacillaraceae, Diatomaceae, Fragilaraceae, Gomphonemaceae, Nitzschaceae, Pinnulariaceae, Surirellaceae, Swirellaceae, Tabellaraceae, Thalassiosiraceae, Epithemaceae and Eunotaceae, in which no purely planktic individual was observed. As the diatoms are non-motile and non-flagellated individuals, they usually occur in attached conditions as epiphyte (Østrup, 1908; Hustedt, 1930; Giffen, 1963; Starmach, 1964; Hohn & Hellermann, 1966).

3. Diversity of localities: The algae were collected from 7 different localities, wherefrom the collected species exhibited variations in their diversities (Table 2). Greatest proportion of algal collections (89.33 %) were made from Lahore City and its neighbouring areas. Largest collections of blue-green and green algae were also made from this district during previous studies (Naz *et al*., 2009, Zarina *et al*., 2009). Probably, it may due to the presence of innumerable water bodies such as rivers, canals, tubewells and fountain-displaying areas at Lahore (Husna *et al*., 2006; Munir *et al*., 2006). Other groups of freshwater algae were also found in abundance at Lahore (Masud-ul-Hasan, 1978a, b, 1980; Masud-ul-Hasan & Yunus, 1989). It was followed by the districts of Gujranwala (24 %) and Kasur (20 %), where appreciable collections were made. The poorest diversity was shown in the collections from the districts of Jhang and Sargodha (4.0 & 5.33 %). During previous studies, poor growth of algae was also recorded for the districts of Jhang and Sargodha (Faridi *et al.,* 1981; Masud-ul-Hasan & Batool, 1987; Naz *et al.,* 2009).

4. Seasonal diversity: The collected diatoms were found in all the four seasons of the year (Table 3). Most of the species were collected in winter (42.66 %), smallest number of them were found in autumn (10.66 %), while in rest of the two seasons they occurred in almost equal proportions (26.66 and 25.33 %). It was similarly observed in other localities of the world (Thomson, 1938; Gerloff & Lüdemann, 1966). Different genera behaved variably in their pattern of seasonal diversity. *Cymbella* occurred mainly (50 %) in spring, *Navicula* (75 %) and *Nitzschia* (44.44 %) were found mainly in winter, while they were collected in all the four seasons of the year. Species of *Surirella, Tabellaria, Rhopalodia* and *Eunotia* were only found in spring, while they were absent in other seasons. Species of *Anomoeoneis* and *Neidium* occurred only in summer, they were not found in other seasons. Species of *Bacillaria*, *Luticola* and *Stauroneis* were found only in autumn, being absent in other three seasons. Species of several genera such as *Amphora, Gyrosigma, Mastogloia, Cymatopleura, Cyclotella* and *Epithemia* occurred during winter season only and could not be collected in other seasons of the year. Certain genera were found in any two seasons and remained absent in the other two seasons. In this regarad, genera of the naviculoid diatoms exhibited great variation in their seasonal diversity among themselves, as was observed quite earlier (Cleve, 1894, 1895).

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