



DIVERSITY AND ABUNDANCE OF DIATOMS IN MANCHENABELE DAM AREA, BANGALORE KARNATAKA

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Abstract: Diatoms constitute a highly diverse lineage of unicellular microorganisms that are abundant and ecologically significant in aquatic ecosystems. They occur either as solitary forms or as colonies, often forming chains, and exhibit a cosmopolitan distribution across a wide range of aquatic habitats. As key primary producers, diatoms play a crucial role in benthic ecosystems and are widely recognized as effective bioindicators of environmental stress. In view of their ecological importance, the present pilot study was undertaken to document the diversity and abundance of centric and pennate diatoms at different locations within the Manchanabele Dam area. The study recorded a total of 14 centric and 27 pennate diatom taxa, belonging to eight and thirteen families, respectively. Among the centric diatoms, the family *Stephanodiscaceae* exhibited the highest species richness, whereas among the pennate diatoms, *Bacillariaceae* and *Fragilariaceae* showed the greatest diversity and abundance. Variations and uneven distribution patterns of diatom populations across the study sites are discussed in relation to local environmental conditions.

Keywords: Diatoms, Centric diatoms, Pennate diatoms, Bioindicators.

I. INTRODUCTION

Diatoms represent one of the earliest recorded groups of microorganisms in India, with the first documentation by Ehrenberg dating back to 1845 in his monumental work *Mikrogeologie* (Jahn, 1995a). Since then, numerous studies have reported diatoms from a wide range of freshwater and marine habitats across the country. Recent estimates suggest that India harbours nearly 6,500 diatom taxa, of which approximately 30% are endemic, reflecting the country's remarkable and unique diatom biodiversity (Balasubramanian, 2023). Microphytobenthos generally consists of diverse algal communities, including cyanobacteria, diatoms, chlorophytes, dinoflagellates, and euglenids (Kristina *et al.*, 2000; Launeau *et al.*, 2018). Diatoms are silicified microalgae, typically microscopic in size, and are functionally unicellular, although they may occur as filaments, chains, or colonies. Based on frustule morphology, diatoms are traditionally divided into two major groups: centric and pennate diatoms. Pennate diatoms are bilaterally symmetrical and usually elongated, whereas centric diatoms are radially symmetrical and composed of upper and lower valves. Most centric and araphid pennate diatoms are non-motile, and their relatively dense siliceous cell walls cause them to sink readily in the water column. Benthic diatoms have been extensively employed as effective tools for assessing water quality in both lotic and lentic ecosystems. They play a crucial role in the biogeochemical cycling of silica and are recognized as significant contributors to global carbon fixation (Willey *et al.*, 2008). Several studies have demonstrated that diatoms are integral components of carbon, nitrogen, phosphorus, and silicate cycles within sediment biofilms, where they inhabit and actively migrate both horizontally and vertically within the upper sediment layers (Morel and Price, 2003; Wilhelm *et al.*, 2006; Prelle *et al.*, 2021). Freshwater diatoms respond directly and sensitively to a wide range of physical, chemical, and biological changes (Rott *et al.*, 2003), making them robust ecological indicators. Consequently, diatoms are widely used as proxies for reconstructing limnological changes and assessing climate-driven variations within aquatic food webs (Smol and Cumming, 2000; Smol and Stoermer, 2010). Studies employing trophic diatom indices have successfully

detected eutrophication in streams of the Himalayan region and the Central Western Ghats (Karthick, 2010; Verma and Nautiyal, 2012; Verma, 2015). Ratha *et al.* (2012) investigated microalgal diversity, particularly Cyanophyta and Chlorophyta, across different ecological habitats in northeastern India using morphological and 18S rDNA analyses. Diatoms constitute a major component of periphyton, and numerous diatom-based indices have been developed for biomonitoring eutrophication and organic pollution (Prygiel *et al.*, 1999). Additionally, morphological abnormalities and deformities in diatom frustules have been reported under metal stress conditions, highlighting their sensitivity to environmental contamination (Falasco *et al.*, 2009a; Morin *et al.*, 2012). Changes in diatom species composition and distribution have also been linked to alterations in hydrological regimes, including the frequency and intensity of droughts and floods, as well as thermal stratification in lakes (Bigler and Hall, 2002; Bigler *et al.*, 2002). Microphytobenthic communities, particularly diatoms, are typically dominated by pennate species that contribute substantially to primary production and regulate nutrient fluxes at the water–sediment interface (Falkowski *et al.*, 1998; Cahoon, 1999). In recent years, diatoms have gained increasing attention due to their applications in forensic science and industrial biotechnology. In forensic investigations, diatoms are valuable indicators in drowning cases, which are commonly accidental or suicidal in nature (Zhao *et al.*, 2016; Manish *et al.*, 2021). Furthermore, owing to their unique siliceous architecture, diatoms have been explored for applications in biofuel production and solar panel development (Hildebrand *et al.*, 2012; Wang and Seibert, 2017).

II. MATERIALS AND METHODS

II.I Study area

Manchanabele Dam is constructed across the River Arkavathy and primarily serves as a source of irrigation water for the surrounding farmlands in and around Magadi town. The dam is located at 12.86702°N latitude and 77.33445°E longitude. It has a height of approximately 23 m and a length of about 147 m, and it plays a significant role in supporting the local ecosystem and agriculture-based livelihoods.



Fig.1 the study area, Manchanabele Dam and Reservoir

The reservoir provides essential irrigation water to nearby agricultural fields, thereby sustaining the agrarian economy of the region. The catchment area is characterized by gently undulating hills and dense vegetation, contributing to the ecological stability of the reservoir environment.

II.II Sampling method

Diatom samples were collected from different locations within Manchanabele Dam, including the spillway, sluiceway, plunge basin, and reservoir areas. The dam is constructed across the River Arkavathy in Ramanagaram District, near Bengaluru. Sampling was carried out during the period from November 2024 to March 2025, following standard protocols described by Karthick *et al.* (2010). Samples were collected from all possible habitats, including epiphytic substrates (aquatic plants) and epilithic substrates (stones), and were stored in plastic containers. The collected samples were preserved in 4% formaldehyde.

Diatom processing and analysis were performed following a modified protocol proposed by Karthick *et al.* (2013). The preserved samples were centrifuged at 3,000 rpm for 10 minutes to obtain concentrated material. Permanent slides were prepared, and diatom taxa were examined under a light microscope. Species identification was based on morphological characteristics described in standard taxonomic references, including Juttner (2003), Taylor *et al.* (2007), and Lavoie *et al.* (2008).

III. RESULTS AND DISCUSSION

Table 1: Pennate Diatom species identified in different location of the study area.

Family (Pennate type)	Species	Nov-24	Dec-24	Jan-25
Achnantheaceae	Achnanthes sp.	+++	+++	++++
Amphipleuraceae	Amphiprora sp	+++	+++	++++
Bacillariaceae	Hantzschia amphioxys v. densestriata	++	++++	++++
	Bacillaria paxillifera	++	+++	+++
	Flagilariopsis sp.	++++	++++	++++
	Cylindrotheca sp.	++++	++	++
	Nitzschia agnita	+++	++	++
	Nitzschia amphibia	++++	+++	+++
	Nitzschia microcephala	+++	++	+++
	Nitzschia sp.	+	++	++
Catenulaceae	Amphora fontinalis	++	+++	++
Cymbellaceae	Cymbella sp.	++	++	++
	Cymbella tumida	++	++	++++
	Cymbella turgida	+	++	+++
Fragilariaceae	Fragilaria intermedia	++++	++++	+++
	Fragilaria ulna	+++	++	+++
	Fragilaria virescens	+++	+++	+++
	Synedra ulna	++++	++++	++++
Gomphonemataceae	Gomphonema sphaeroporium	+++	++	+++
Pleurosigmataceae	Gyrosigma sp.	++++	+++	++++
	Plagiotropis sp.	+++	++	++++
	Pleurosigma sp.	+++	++	+++
Licmophoraceae	Licmophora sp.	++++	+++	+++
Naviculaceae	Navicula salinarum	+++	+++	++++
Rhizosoleniaceae	Rhizosolenia sp.	+++	++	++++
Rhoicospheniaceae	Rhoicosphenia sp.	+++	+	+++
Thalassionemataceae	Thalassiothrix sp.	+	+	+++

A total of 14 and 27 taxa belonging to eight and 13 families of Centric and Pennate species respectively have been reported from the study area. Among pennate species; Achnantheaceae (*Achnanthes* sp.), Amphipleuraceae (*Amphiprora* sp.), Bacillariaceae (*Hantzschia amphioxys* v. *densestriata*, *Bacillaria paxillifera*, *Flagilariopsis* sp., *Cylindrotheca* sp., *Nitzschia agnita*, *Nitzschia amphibia*, *Nitzschia microcephala*, *Nitzschia* sp.), Catenulaceae (*Amphora fontinalis*), Cymbellaceae (*Cymbella* sp., *Cymbella tumida*, *Cymbella turgida*); Fragilariaceae (*Fragilaria intermedia*, *Fragilaria ulna*, *Fragilaria virescens*, *Synedra ulna*); Gomphonemataceae (*Gomphonema sphaeroporium*); Pleurosigmataceae (*Gyrosigma* sp., *Plagiotropis* sp., *Pleurosigma* sp.); Licmophoraceae (*Licmophora* sp.); Naviculaceae (*Navicula salinarum*); Rhizosoleniaceae (*Rhizosolenia* sp.); Rhoicospheniaceae (*Rhoicosphenia* sp.) and Thalassionemataceae (*Thalassiothrix* sp.) were the major families. The families Bacillariaceae comprises eight species, followed by Fragilariaceae with four species, Cymbellaceae and Pleurosigmataceae with three species each. Whereas, Achnantheaceae, Amphipleuraceae, Catenulaceae, Gomphonemataceae, Licmophoraceae, Naviculaceae, Rhizosoleniaceae, Rhoicospheniaceae and Thalassionemataceae comprises one species each (Table 1).

Table 2: Centric Diatom species identified in different location of the study area.

Family (Centric type)	Species	Nov-24	Dec-24	Jan-25
Aulacoseiraceae	<i>Aulacoseira granulata</i>	++	+++	+++
Biddulphiaceae	<i>Hydrosera triquetra</i> Wallich	+	++	++
Chaetocerotaceae	<i>Chaetoceros</i> sp.	-	+	+
Melosiraceae	<i>Melosira varians</i>	-	++	++
Orthoseiraceae	<i>Orthoseira punctata</i>	++	+++	+++
Paraliaceae	<i>Ellerbeckia arenaria</i>	+	++	+
Rhizosoleniaceae	<i>Urosolenia</i> sp.	++	+++	+++
Stephanodiscaceae	<i>Puncticulata balatonis</i>	+	++	+
	<i>Spicaticribr</i> a kodaikanaliana	++	+++	++
	<i>Stephanodiscus hantzschii</i>	++	++	+
	<i>Lindavia biswashanti</i>	++	+	+++
	<i>Cyclostephanos</i> sp.	+	++	+++
	<i>Cyclotella</i> sp.	++	++	++++
	<i>Discostella stelligera</i>	++	++	+++

Among centric species, Aulacoseiraceae (*Aulacoseira granulata*), Biddulphiaceae (*Hydrosera triquetra* Wallich), Chaetocerotaceae (*Chaetoceros* sp.) Melosiraceae (*Melosira varians*), Orthoseiraceae (*Orthoseira punctata*), Paraliaceae (*Ellerbeckia arenaria*), Rhizosoleniaceae (*Urosolenia* sp.) Stephanodiscaceae *Puncticulata balatonis*, *Spicaticribr*a kodaikanaliana, *Stephanodiscus hantzschii*, *Lindavia biswashanti*, *Cyclostephanos* sp., *Cyclotella* sp., and *Discostella stelligera* were from centric type of diatoms. The family Stephanodiscaceae comprises seven species (Table 2). Among the total diatom, the family Stephanodiscaceae was the most species-rich, represented by seven taxa, followed by Aulacoseiraceae, Orthoseiraceae, Rhizosoleniaceae, Paraliaceae, Biddulphiaceae, Chaetocerotaceae, and Melosiraceae with one species each. The growth of Stephanodiscaceae were significantly influenced by the water temperature during spring. The diversity of dominants Stephanodiscaceae species is evidence for the stability of the autotrophic segment (Mitrofanova, 2000; Hulyal, and Kaliwal 2009; Shijila Rani *et al.*, 2022). Further, Jirsová (2024) revealed that *Stephanodiscaceae* playing a crucial role in the aquatic food web and persistence of these taxa across all seasons suggests that these taxa might be able to thrive in a broad range of environmental conditions and might be less sensitive to seasonal temperature fluctuations. The species *Aulacoseira granulata*, *Orthoseira punctata*, and *Urosolenia* sp. were consistently abundant throughout the study period, showing peak abundance during December and January. *Cyclotella* sp. exhibited the highest relative abundance in January 2025, indicating favourable winter conditions for its proliferation. Seasonal variations in species occurrence were evident. Certain taxa such as *Chaetoceros* sp. and *Melosira varians* were absent in November but appeared during December and January, suggesting seasonal establishment. In contrast, species like *Stephanodiscus hantzschii* and *Puncticulata balatonis* showed a decline in abundance towards January. Overall, centric diatoms displayed higher diversity and abundance during December and January compared to November, reflecting the influence of seasonal hydrological stability and nutrient availability in the reservoir ecosystem.

Among the recorded pennate diatom families, Bacillariaceae and Fragilariaceae were the most dominant in terms of species richness and relative abundance, followed by Cymbellaceae, Pleurosigmataceae, and Gomphonemataceae. The remaining families were represented by one or two species each (Table 2). Several pennate taxa exhibited consistently high abundance throughout the study period. *Achnanthes* sp. and *Amphiprora* sp. showed very high abundance, reaching peak levels in January 2025. Within Bacillariaceae, species such as *Flagilariopsis* sp., *Nitzschia amphibia*, and *Hantzschia amphioxys* var. *densestriata* were highly abundant across all months, indicating their strong adaptability to reservoir conditions. *Cylindrotheca* sp. and *Nitzschia agnita* showed relatively higher abundance during November, followed by a decline in December and January. Members of Fragilariaceae, particularly *Fragilaria intermedia*, *Fragilaria virescens*, and *Synedra ulna*, dominated the pennate assemblage. *Synedra ulna* remained highly abundant during all three months, while *Fragilaria intermedia* showed slightly reduced abundance in January. Cymbellaceae species such as *Cymbella tumida* and *Cymbella turgida* exhibited an increasing trend towards January, suggesting favourable winter conditions. Pleurosigmataceae taxa, including *Gyrosigma* sp. and *Plagiotropis* sp., displayed marked seasonal variation, with higher abundance recorded during November and January.

Licmophora sp. (Licmophoraceae) and *Navicula salinarum* (Naviculaceae) were also consistently abundant, particularly during January. Overall, pennate diatoms showed greater diversity and dominance compared to centric diatoms, reflecting the benthic nature of the reservoir and stable substrate availability during the study period (Nashima and Palanisamy 2016; Raut, *et al.*, 2026). Further Khan, (1990) and Trivedy and Goel, (1984) and Tapia, (2008) stated that Bacillariaceae and Fragilariaceae are the most pollution tolerant species and are also bioindicators of pollution.

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