International Journal of Leading Research Publication (IJLRP)

E-ISSN: 2582-8010 ● Website: www.ijlrp.com ● Email: editor@ijlrp.com

Assessment of Hydrophytic Plant Diversity and Phytoplankton Composition in Sinhad Talab, Rajasthan

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Abstract:
The present study investigates the diversity of hydrophytic plants and phytoplankton composition in Sinhad Talab, Rajasthan, with the aim of understanding the ecological status of this freshwater ecosystem. Aquatic ecosystems are highly sensitive to environmental variations, and both hydrophytic vegetation and phytoplankton serve as reliable indicators of water quality and trophic conditions. In the present investigation, phytoplankton and aquatic plant diversity were assessed seasonally along with their response to physicochemical conditions of the water body. A total of 24 phytoplankton species belonging to five major groups Chlorophyceae, Cyanophyceae, Bacillariophyceae, Charophyceae, and Euglenophyceae were recorded. Bacillariophyceae emerged as the dominant group followed by Chlorophyceae, indicating a moderately nutrient-rich (mesotrophic to eutrophic) condition of the pond. Seasonal variation revealed maximum phytoplankton abundance during summer and minimum during the rainy season, strongly influenced by temperature, nutrient availability, water level fluctuations and light penetration. Cyanobacterial blooms, particularly of *Microcystis aeruginosa*, indicated episodic eutrophication and organic enrichment. The study highlights that Sinhad Talab supports a diverse aquatic community but is experiencing increasing ecological stress due to nutrient loading and seasonal environmental fluctuations. The findings provide a baseline for future ecological monitoring and sustainable management of freshwater resources in semi-arid regions of Rajasthan.

1. Introduction

Aquatic ecosystems are vital components of the natural environment, providing essential ecological services such as biodiversity conservation, nutrient cycling, water purification and climate regulation (Wetzel, 2001; Dodds & Whiles, 2010; Kumar & Gupta, 2025). Among these, freshwater bodies like ponds, lakes and wetlands support a diverse range of biota, including hydrophytic (aquatic) plants and phytoplankton, which play a fundamental role in maintaining ecological balance (Kalff, 2002; Mishra & Sharma, 2026; Barupal, & Chishty, 2025). Hydrophytic plants stabilize sediments, absorb nutrients and provide habitat for a wide array of organisms, while phytoplankton serve as primary producers and are crucial for sustaining aquatic food webs (Reynolds, 2006).

Phytoplankton communities are sensitive indicators of water quality, as their abundance and composition directly respond to nutrient availability, light conditions, temperature and anthropogenic influences (Palmer, 1969; Sharma & Tiwari, 2018). Similarly, the diversity and structure of hydrophytic vegetation can reflect the ecological health of freshwater ecosystems (Bornette&Puijalon, 2011; Kamei, et al. 2025). Therefore, the combined assessment of hydrophytic plants and phytoplankton offers valuable insights into the status and functioning of aquatic environments (Prasad, & Verma, 2025; Sampath, et al., 2025).

Sinhad Talab, located near the holy town of Nathdwara, is not only a natural resource but also holds cultural and religious significance (Sharma & Walia, 2017; Venkatesh et al., 2025). The talab (pond)

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supports a diverse range of flora and fauna and is an integral part of the local hydrological system (Manjare et al., 2010; Mobin et al., 2014). However, rapid urbanization, agricultural runoff and other anthropogenic activities have increasingly threatened its ecological integrity (Khalik et al., 2013).

Despite its ecological importance, comprehensive studies on the biological diversity of Sinhad Talab, particularly in terms of hydrophytic plants and phytoplankton, remain limited. A systematic investigation of these biological components is essential for understanding the ecological dynamics of the pond and for developing strategies for its sustainable management.

The present study aims to assess the diversity, composition and ecological roles of hydrophytic plants and phytoplankton in Sinhad Talab. By documenting species richness and evaluating the distribution patterns of these aquatic communities, this research seeks to contribute to the broader understanding of freshwater biodiversity in arid and semi-arid regions of India, and to serve as a reference point for future ecological monitoring and conservation efforts.

2. Materials and Methods

2.1. Study area

The present investigation was conducted in *Sinhad Talab*, located in Rajasthan, India. The pond represents a typical freshwater ecosystem supporting diverse hydrophytic vegetation and phytoplankton communities. The site was selected to assess the diversity of aquatic macrophytes and phytoplankton composition under natural environmental conditions (Fig. 1)**.**

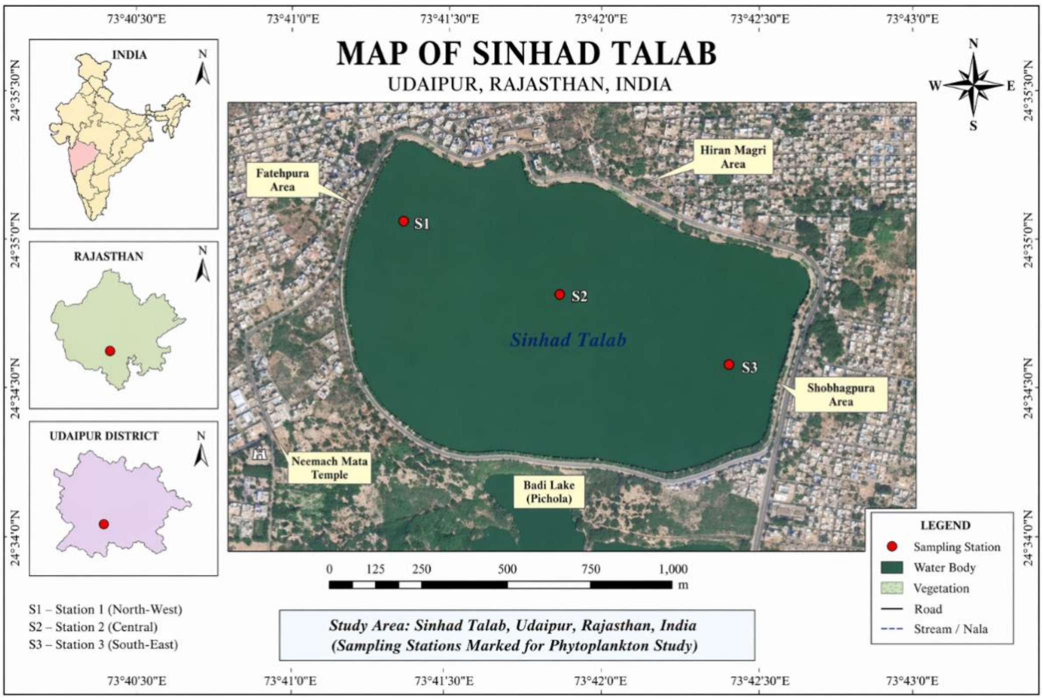

Figure.1. Illustration of Sinhad Talab, Udaipur, Rajasthan, India, showing sampling locations for phytoplankton study.

2.2. Phytoplankton analysis

Sampling of phytoplankton was carried out for qualitative analysis in once in a month and for period of 1-year 2019 (Jan-Dec) from selected three different locations of Talab. That were: Location 1. Inlet Zone (Entry Point) 2. Central Zone (Mid-water region) 3. Outlet / Peripheral Zone.

Further, the phytoplankton samples were collected using standard phytoplankton net made of bolting silk (number of 12 with 0.3 mm mesh). Several hundred litres of lake water were filtered through phytoplankton net with the help of plastic basket and the sample so collected transferred to wide mouthed bottle and preserved using Lugol's iodine solution. Phyto benthos were also collected for study. The preserved phytoplankton sample were analyzed after the suitable settlement of the algal remains. The sample were inspected under the microscope lens (10x 40x 100x) followed by capturing images of phytoplankton with the help of digital camera. The identification of phytoplankton was made following standard works published in books, journals and monographs. (Ali, 2010)(Ogashawara et al., 2017)(Wagner & Pruß, 2002) (Asai et al., 2009)etc. Also, photographs of captured phytoplankton were sent to Dr. Ramakant Ojha , Associate Professor and Algologist to confirm identification.

2.3. Statical analysis

In order to account all the major monthly and seasonal environment alteration of the study area, the data in the month-wise analysis, the measurement values of three selected Locations were sum up into the average of particular month, which reveals the variation of studied parameters month-wise. In season-wise analysis, the four months measurements done were grouped into average of three seasons such as the winter season (November, December, January, February), summer season (March, April, May, June) and rainy season (July, August, September, October). Comparison of physicochemical parameters in different seasons explains the fluctuation range of parameters. The data of examined physiochemical parameters of study area were calculated using the ANOVA (analysis of variance) to derive mean, monthly variation, seasonal variation and correlation coefficients among the studied physicochemical parameters.

3. Results and Discussion

Phytoplankton diversity of Sinhad talab

The phytoplankton analysis of the studied aquatic system revealed the presence of four major algal groups, namely **Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae**. Among these, **Chlorophyceae** was the most dominant group, comprising a total of 20 species, followed by **Bacillariophyceae** with 16 species. In contrast, **Cyanophyceae** showed moderate diversity with 7 species, whereas **Euglenophyceae** was least represented with only 3 species. The Chlorophyceae group included genera such as *Chlorella*, *Chlamydomonas, Volvox, Spirogyra*, and *Scenedesmus*, indicating a wide diversity of green algae in the water body. Bacillariophyceae was represented by diatoms like *Navicula, Pinnularia, Nitzschia* and *Cymbella*, suggesting a significant contribution of silica-requiring phytoplankton. Cyanophyceae included genera such as *Oscillatoria, Nostoc, Anabaena,* and *Spirulina*, while Euglenophyceae was represented by *Euglena* species(Table 1)**.**

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Table 1 Diversity status of algal flora of Sinhad talab (2022).

Sr. no.	Chlorophyceae	Bscillariophysceae	Cyanophyceae	Euglenophyceae
1.	*Chlorella vulgaris*	*Pinnularia*	*Chroococcus*	*Euglena deses*
2.	*Chlamydomonas sp.*	*Calonies*	*Gloeocapsa*	*Euglena viridis*
3.	*Fudorina elegance*	*Stauromeis*	*Oscillatoria*	*Euglena gracilis*
4.	*Pediastrum duplex*	*Cyclotella*	*Nostoc*	
5.	*Ulothrix sp.*	*Tabellaria*	*Spirulina*	
6.	*Oedogonium*	*Synedra*	*Anabaena*	
7.	*Cladophora*	*Cocconeis*	*Rivularia*	
8.	*Spirogyra*	*Nitzschia*		
9.	*Closteridium*	*Gomphonema*		
10.	*Cosmarium*	*Diploneis*		
11.	*Staurastrum*	*Gyrosigma*		
12.	*Chlorococcum*	*Cymbella*		
13.	*Ankistrodesmus*	*Rhopulodia*		
14.	*Scenedesmus*	*Fragillaria*		
15.	*Actinastrum*	*Naviculasp*		
16.	*Desmidium sp.*	*Fragillaria*		
17.	*Pendorina sp.*			
18.	*Oocystis*			
19.	*Volvox sp.*			
20.	*Hydrodiction*			

3.1 Seasonal Variation in Phytoplankton Diversity

The present study on Sinhad Talab (Rajasthan) revealed a distinct seasonal variation in phytoplankton diversity during the study period (2022). The total phytoplankton abundance was highest during the summer season, while the rainy season exhibited minimum diversity. This seasonal fluctuation indicates that phytoplankton distribution in the water body is strongly influenced by physicochemical parameters such as temperature, pH, nutrient availability and water level.

The increased phytoplankton diversity during summer can be attributed to elevated water temperature, higher evaporation rate and concentration of nutrients, which collectively enhance primary productivity. Higher temperature accelerates decomposition of organic matter, thereby increasing nutrient availability, which favors phytoplankton growth. Similar observations have been reported by Tyor and Deepti (2012) and Chaturvedi et al. (1999), who emphasized that warm temperature and longer photoperiod enhance phytoplankton proliferation.

Additionally, low water level, increased alkalinity, higher CO_2 concentration, and suspended nutrient load during summer further support phytoplankton abundance (Singhal, et al. 2026). Comparable seasonal trends have been documented in several freshwater ecosystems by Sreenivasan et al. (1972), Laskar and Gupta (2009), and Rawat and Trivedi (2018).

In contrast, the decline in phytoplankton diversity during the rainy season may be due to heavy rainfall, surface runoff, dilution effect, increased turbidity, reduced light penetration, and lowered water temperature. Increased water volume and reduced nutrient concentration during monsoon also suppress algal growth. Similar findings have been reported by Pundhir and Rana (2002), Rajkumar et al. (2009), and Sharma et al. (2015). Overall, the present study shows a typical pattern of summer maxima and monsoon minima, consistent with earlier reports from Indian freshwater ecosystems (Kumar & Gupta, 2002; Janjua et al., 2009; Bronzoni-Oliveira, et al. 2026).

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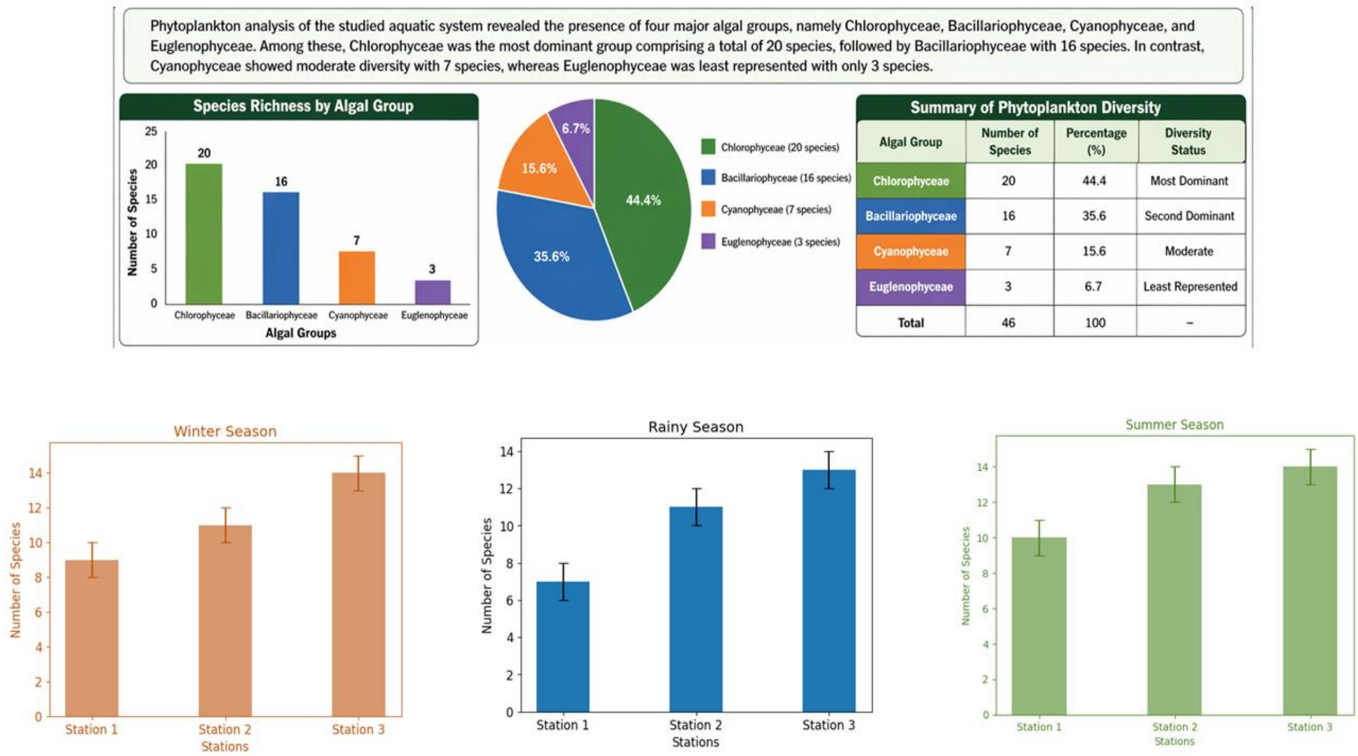

Figure 2. Graphical representation of phytoplankton diversity and seasonal variation in Sinhad Talab, Udaipur, Rajasthan, India.

3.2 Phytoplankton Composition and Community Structure

A total of 24 phytoplankton species belonging to five major groups were recorded: Chlorophyceae, Cyanophyceae, Bacillariophyceae, Charophyceae and Euglenophyceae. Among these, Bacillariophyceae was the most dominant group, followed by Chlorophyceae, Cyanophyceae, Charophyceae and Euglenophyceae. This dominance indicates that diatoms play a key role in primary productivity of Sinhad Talab. Similar dominance of diatoms has been reported by Kotadiya and Mulia (2014) and Ganai et al. (2010).This distribution reflects a moderately nutrient-rich (mesotrophic to eutrophic) condition of the water body, as phytoplankton composition is closely linked to nutrient availability and water quality. According to Sukumaran and Das (2002) and Butterwick et al. (2005), nutrient enrichment significantly influences phytoplankton succession in freshwater ecosystems.

Chlorophyceae

Chlorophyceae contributed approximately 21% of total phytoplankton diversity and was represented by species such as *Spirogyra*, *Zygnema*, *Oedogonium*, *Cladophora* and *Ulothrix*. Maximum abundance was recorded during summer, while minimum during the rainy season. The dominance of Chlorophyceae in summer is associated with high temperature, alkaline pH and reduced water volume, which favor their growth. Similar observations have been reported by Kumar & Gupta (2002), Sakhare (2006) and Singh (2008).

Cyanophyceae

Cyanophyceae constituted about 14% of total phytoplankton, represented by *Microcystis*, *Oscillatoria*, *Nostoc* and *Spirulina*. The group showed maximum abundance during summer. The dominance of cyanobacteria indicates eutrophic conditions and organic pollution in the water body. *Microcystis aeruginosa* was frequently observed and formed blooms, particularly during summer, suggesting nutrient enrichment and stagnant water conditions. Similar observations have been reported by Singh R.N. (1953), Chellapa *et al.* (2008) and Vijayveria (2008).

Bacillariophyceae

Bacillariophyceae was the second most dominant group (25.34%), represented by genera such as *Navicula*, *Nitzschia*, *Synedra*, *Cyclotella*, *Cymbella* and *Gomphonema*. Diatoms showed maximum abundance during summer and minimum during rainy season. The dominance of diatoms indicates alkaline and nutrient-rich conditions. Their abundance is strongly influenced by temperature and silica availability. Similar results were reported by Hulyal and Kaliwal (2009) and Harikrishnan *et al*. (1999).

Euglenophyceae

Euglenophyceae was the least represented group (4% contribution) and was represented mainly by *Euglena* spp. Its abundance was higher in summer and rainy season compared to winter. The presence of Euglena indicates organic pollution and high BOD conditions, as it is known to tolerate polluted environments (Patrick, 1965). However, its low diversity suggests moderate organic load in Sinhad Talab.

The overall phytoplankton community structure suggests that Sinhad Talab exhibits moderate eutrophic characteristics, with seasonal nutrient fluctuations strongly influencing species composition. Dominance of diatoms and chlorophytes indicates relatively stable productivity, whereas the presence of cyanobacterial blooms suggests episodic nutrient enrichment. The seasonal pattern clearly reflects that temperature, light availability and nutrient dynamics are the primary drivers of phytoplankton succession in this freshwater ecosystem.

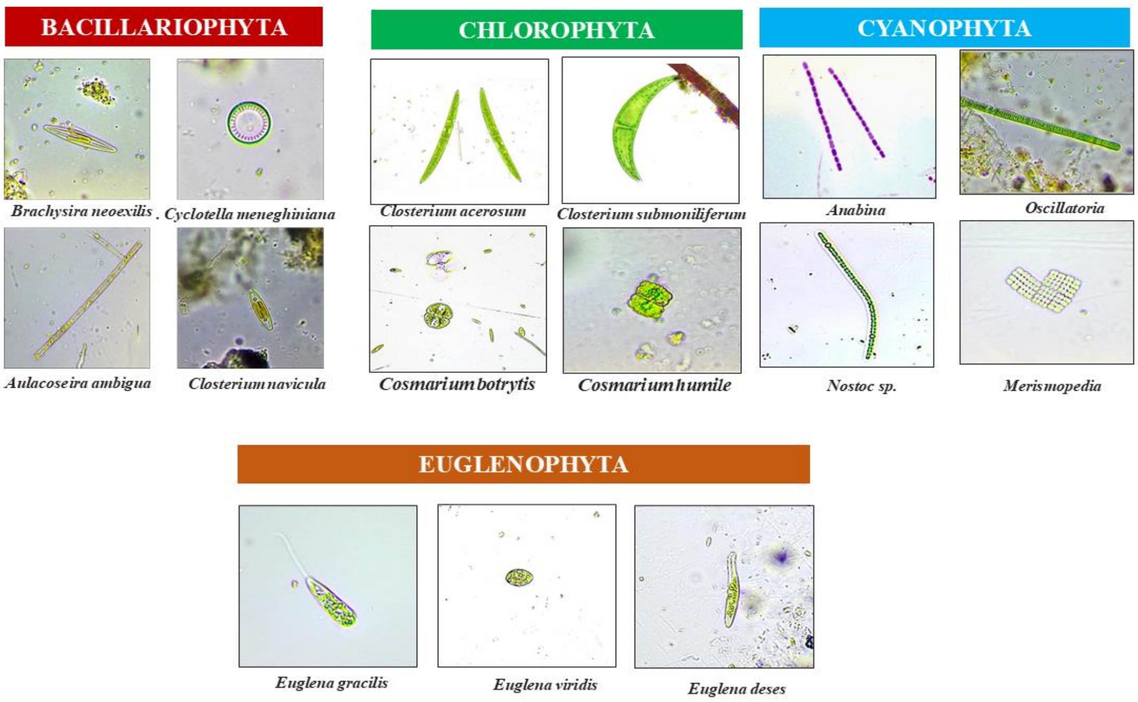

Figure: 3. Representative micrographs of phytoplankton taxa recorded from Sinhad Talab, Udaipur, Rajasthan, India, showing major algal groups

Conclusion

The present investigation on Sinhad Talab clearly demonstrates that both hydrophytic plant diversity and phytoplankton composition are strongly governed by seasonal and physicochemical variations. The study recorded a rich phytoplankton diversity dominated by Bacillariophyceae and Chlorophyceae, indicating that the pond supports moderate productivity and nutrient enrichment conditions. Seasonal analysis revealed that summer conditions favor maximum phytoplankton growth due to higher temperature, increased nutrient concentration, and enhanced decomposition processes, whereas the rainy season leads to dilution, reduced light availability and decreased phytoplankton abundance. The occurrence of cyanobacterial blooms, particularly *Microcystis aeruginosa*, suggests intermittent eutrophication and organic pollution in the water body. The presence of Euglenophyceae further supports the influence of organic enrichment, while diatom dominance reflects relatively alkaline and nutrient-rich conditions. Overall, the ecological status of Sinhad Talab can be categorized as mesotrophic to mildly eutrophic. The study emphasizes that continuous monitoring of aquatic vegetation and phytoplankton communities is essential for assessing water quality changes and ecological health. The results provide a baseline dataset for future research and highlight the need for conservation strategies to prevent further degradation of this freshwater ecosystem due to anthropogenic pressures and nutrient loading.

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