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Seasonal variations and diversity of freshwater algae from Girna River in Malegaon Tehsil of Nashik District (Maharashtra, India)

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Abstract
Freshwater ecosystems depend on algae as primary producers and trustworthy bioindicators of water quality. The goal of the current study, "Study of Algal Diversity from Girna River in Malegaon Tehsil of Nashik District," was to evaluate the seasonal variation, composition, and distribution of the algal flora in the Girna River that flows through Malegaon, which is in the Nashik district of Maharashtra, India. During the year (June 2023 to May 2024) study in various seasons, systematic sampling was done from three different locations along the river. Standard techniques for microscopic and taxonomic identification were used to gather, preserve, and examine the samples.
A wide variety of algal groups, primarily from the Chlorophyceae, Bacillariophyceae, Cyanophyceae, and Euglenophyceae families, were found in the study. Green algae (Chlorophyceae) and Diatoms (Bacillariophyceae) were found to be the most prevalent of these. Seasonal variations were noted, summer season followed by winter showing relatively higher diversity and monsoon seasons showing lower diversity. At some locations, the existence of specific species that can withstand pollution suggests a moderate level of human influence.
The results underline the Girna River's ecological importance as a habitat for a variety of algal communities and the function of algal diversity as a river health indicator. For upcoming ecological monitoring, conservation planning, and sustainable freshwater resource management in the Malegaon region, this study offers baseline data.

Keywords: Algal diversity, Girna River, Malegaon, freshwater ecosystem, bioindicators, seasonal variation

Introduction
Freshwater ecosystems sustain a diverse array of aquatic organisms and are dynamic, biologically productive systems. Algae are among the most important of these, serving as the main producers in aquatic food webs (Stevenson, J. 2014) [12]. They play a significant role in the creation of oxygen, the cycling of nutrients, and the transfer of energy in freshwater environments. Algal communities are widely acknowledged as trustworthy bioindicators of ecological status and water quality because of their quick reaction to environmental changes (Ahmed, S. 2024) [3].
Rivers, being lotic ecosystems, show significant seasonal and spatial fluctuations that are impacted by hydrology, climate, and human activities. Temperature, pH, dissolved oxygen, nutrient concentration, and turbidity are examples of physicochemical parameters that directly impact the distribution and composition of algal flora. Therefore, research on algal diversity in riverine systems offers important information about the health of ecosystems, pollution levels, and general water quality (Abidin, Z. U. *et al*. 2025) [7].
The Girna River is one of the important rivers in Maharashtra and serves as a significant water resource for irrigation, domestic consumption, and small-scale industrial activities. Flowing through Malegaon tehsil in Nashik district, the river is subjected to increasing anthropogenic pressures including urban runoff, agricultural discharge, and effluent input. Such activities may influence the biological composition of the river, particularly the algal communities (Agarwal, V., & Kumar, M. 2024) [2]. The name Girna comes from the goddess Girja, also known as Parvati. This started at the Kem peak in the Western Ghats Mountain range and flows through Nasik District in an easterly direction. where the Mausam River is connected to Malegaon. The British-built Chanakapur Dam, near Abhona in the Kalwantehsil, where the Sarpaganga River joins the Girna, is the biggest dam on the river. Fertile soil has been intensively formed in the river basin valley on the Deccan Plateau. The Girna River joins the Tapi River after 260 kilometers of travel (Fig.- 1).
There are still few thorough studies that particularly address the diversity of algae in the Malegaon region, despite the Girna River's ecological and economic significance (Pagar, V. B., & Patil, R. K. 2025) [7]. For long-term ecological monitoring and sustainable river management, baseline data on algal taxa and their seasonal variation must be established. Investigating the diversity, composition, and seasonal variation of the algal flora in the Girna River within the Malegaon tehsil of the Nashik district is the goal of the year (June 2023 to May 2024) [2] study. The results of this investigation will aid in the comprehension of the river's ecological condition and offer scientific information that is helpful for planning conservation efforts and managing water resources (Wohl, E., *et al*. 2015) [14].

Materials and Methods
1. Study Area
The Girna River, which flows through Malegaon tehsil of Nashik district, Maharashtra, India, was the site of the

current investigation (**Fig. 1**). A significant source of water for irrigation, household use, and small-scale industrial operations in the area, the Girna River is a tributary of the Tapi River. Anthropogenic activities, water flow variation, and accessibility were taken into consideration when choosing sampling locations for this study. In the Malegaon region, three representative sites were found, including upstream (less disturbed), midstream (moderately disturbed), and downstream (highly disturbed) areas.

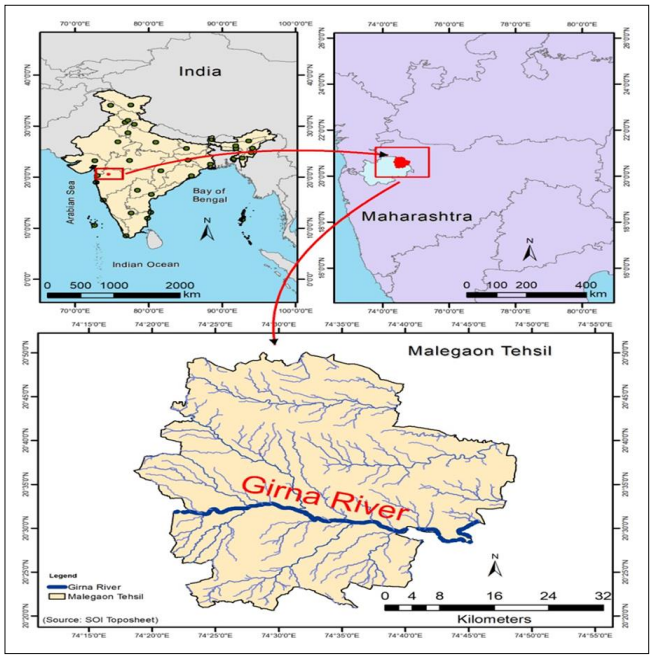

Fig 1: Geographical Position of Girna River in Malegaon tehsil of Nashik district Maharashtra.

2. Sampling Period

Algal samples were collected seasonally for the year (June 2023 to May 2024) to study seasonal variation. Sampling was conducted during monsoon, post-monsoon, winter, and summer seasons from three representative sites including upstream (less disturbed), midstream (moderately disturbed), and downstream (highly disturbed) areas.

3. Sample Collection

Water and algal samples were collected from three representative sites including upstream (less disturbed), midstream (moderately disturbed), and downstream (highly disturbed) areas in the early morning hours (8:00 AM–11:00 AM).

- Planktonic algae were collected by filtering 50–100 liters of river water through a standard plankton net (mesh size 20–25 µm).
- Periphytic algae were collected by scraping submerged stones, aquatic plants, and other substrates using a brush and scalpel.
- Samples were transferred into clean, labelled polyethylene bottles.

All samples were preserved immediately using 4% formalin solution for further laboratory analysis.

4. Physico-Chemical Analysis of Water

In order to analyse physico-chemical properties total 17 different parameters were simultaneously collected.

- Water temperature was recorded on-site using a mercury thermometer.

pH was measured using a digital pH meter.

- Dissolved oxygen was estimated by Winkler's method.
- Other parameters were analysed in the laboratory following standard procedures (APHA guidelines).

5. Identification and Enumeration of Algae

Preserved samples were left to settle for 24 to 48 hours in the lab. To concentrate the sample, the supernatant was carefully decanted. A compound light microscope was used to view the temporary slides that were prepared.

Based on morphological traits like cell size, shape, pigmentation, and colony formation, standard taxonomic keys and monographs were used to identify algae taxa down to the genus and species level (Bellinger, E. G., & Sigee, D. C. 2015) [4]. Standard literature was used to confirm the identification.

Results and Discussion

1. Composition and Diversity of Algal Flora

The current study found that the Girna River, which flows through Malegaon tehsil in Nashik district, Maharashtra, has a rich diversity of algal taxa. Throughout the study period, a total of (approximately) 57 species were identified, grouped into four major classes: Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae

In terms of species richness and abundance, Chlorophyceae (Green algae) was the most prevalent class among these groups, followed by Bacillariophyceae (diatoms). Although they were relatively less common, Cyanophyceae (blue-green algae) and Euglenophyceae were clearly visible at locations where human disturbances had occurred.

Since many algal species prefer well-oxygenated flowing waters, the predominance of algae suggests comparatively favourable ecological conditions. Genera such as *Cosmarium Pediastrum, Spirogyra, Cymbella, Fragilaria & Navicula* were frequently dominant. At downstream locations, the presence of genera that can withstand pollution, like *Oscillatoria and Euglena*, indicates organic enrichment and moderate pollution levels.

2. Species Density and Seasonal variation

Distinct seasonal fluctuations were recorded in algal diversity and density:

- The greatest species diversity and abundance occurred during the summer and winter seasons. Algal growth was encouraged during this time by moderate water temperatures, a moderate flow rate, and better light penetration.
- Due to increased water current and high turbidity, which may have decreased planktonic stability, the monsoon season showed moderate diversity.
- While some tolerant species were more abundant during the summer, overall diversity was relatively high. In certain places, Cyanophyceae growth may have been aided by decreased water volume and elevated nutrient concentration.

3. Relationship with Physico-Chemical Parameters

Algal distribution showed clear correlation with physicochemical parameters:

- The water temperatures at the research sites are recorded at their lowest points in the winter and at their highest points in the summer.
- Throughout the study, the water at every location in the research area was generally alkaline (pH>7). There was less alkaline water during the monsoon and more during the summer.

Over the course of the study, dissolved oxygen concentration values were generally higher in the winter and lower in the summer.

- The water's BOD & COD levels at the research sites are highest in the summer and lowest in the winter.
- The total dissolved solids in the water at the research sites are measured at their lowest point during the monsoon and at their highest point during the winter.
- The turbidity of the water is measured at the research sites, peaking during the monsoon and falling during the summer.
- The research study measures the water's total suspended solids at its highest point during the monsoon and its lowest point during the winter.

The observation of moderate organic contamination at some locations is supported by the presence of pollution-indicator species like *Oscillatoria,* and *Euglena*.

Table 1: Seasonal variation of algal taxa recorded (- absent, + present, ++ abundant, +++ dominant)

Name of taxa	Summer (February -May)	Monsoon (June- September)	Winter (October- January)
Chlorophyceae (23)			
Ankistrodesmus falcatus	+++	+	++
Chara vulgaris	-	+	++
Chlamydomonas globosa	+	-	+
Chlorella vulgaris	++	++	++
Cladophora prolifera	++	+	++
Closterium incurvum	+++	-	++
Cosmarium depressum	+++	++	+++
Cosmarium regnellii	+++	+	++
Desmodesmus serratus	++	+	+
Euastrum spinulosum	-	-	+
Haematococcus pluvialis	+	-	-
Micrasterias laticeps	+	+	-
Nephrocytium lunatum	+	-	+
Pediastrum duplex	+++	+	+++
Pediastrum tetras	++	+	+
Scenedesmus obliquus	+	-	-
Spirogyra biformis	+++	+++	+++
Spirogyra maxima	++	+	+++
Spirogyra porticalis	+++	++	++
Staurastrum manfeldtii	+	+	++
Tetraedron gracile	+	-	+
Ulothrix zonata	+	+	++
Zygnema terrestre	++	+	++
Bacillariophyceae (18)			
Amphora ovalis	+++	+	+++
Cyclotella antique	+	-	-
Cymbella aspera	+++	++	+++
Cymbella gracilis	+++	+	++
Cymbella turgidula	++	+	+++
Denticula elegans	+	-	+
Fragilaria capucina	+++	++	++
Fragilaria intermedia	+++	++	++
Gomphonema olivaceum	++	+	+
Gyrosigma maharashtrensis	+++	+	+++
Mastogloia calcarea	++	-	++
Melosira granulata	+	+	+
Navicula gregaria	+++	++	+++
Navicula viridula	+++	+	++
Nitzschia sigma	++	+	+
Pinnularia dolosa	++	+	+++
Surirella linearis	-	-	+
Synedra acus	++	+	+++
Cyanophyceae (13)			
Anabaena torulosa	+	++	++
Aphanocapsa grevillei	+++	++	++
Aphanothece saxicola	++	+	+++
Chroococcus tenax	++	+	+
Chroococcus turgidus	++	+	++

Cylindrospermum stagnale	+	+	++
Komvophoron schmidlei	++	-	+
Lyngbya aestuarii	+++	+	++
Merismopedia elegans	+++	++	+++
Microcystis wesenbergii	++	+	+++
Oscillatoria limosa	+++	+	++
Oscillatoria willei	++	++	+++
Spirulina major	+	+	+
Euglenophyceae (3)			
Euglena texta	+	+	++
Lepocinclis fusiformis	++	+	-
Phacus orbicularis	+	-	-

Table 2: Physico-chemical parameters of three different season during June 2023 to May 2024

Sr. N0.	Parameters	Year (June 2023 to May 2024)									Mean	SD
		Mansoon			Winter			Summer				
		Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3		
1	Water Temperature, °C	29.38	26.98	30.44	16.25	17.52	14.57	34.25	36.11	35.58	26.78	8.56
2	pH	7.12	7.16	6.54	7.57	7.47	7.86	8.45	8.12	7.68	7.55	0.57
3	Dissolved oxygen (DO), (mg/L)	7.1	5.9	6.8	7.3	8.2	6.9	4.2	5.3	4.6	6.25	1.33
4	BOD (mg/L)	2.6	2.9	2.6	2.2	2.1	1.9	3.7	3.8	4.2	2.88	0.82
5	COD (mg/L)	7.67	7.42	6.62	4.58	4.67	4.11	9.27	8.59	9.45	6.93	2.06
6	Total dissolved solids (TDS), (mg/L)	148.6	155.7	145.2	119.1	124.9	131.2	131.5	130.5	136.9	135.95	11.80
7	Turbidity, (NTU)	4.69	5.16	5.27	2.61	3.46	2.78	1.25	1.64	1.21	3.11	1.62
8	Total suspended solids (TSS), (mg/L)	23.64	24.12	24.65	11.26	14.26	12.64	18.64	16.64	19.25	18.34	5.05
9	Electrical conductivity (EC), (µS/cm)	158	165	159	111	99	110	131	122	133	132	24.00
10	Total alkalinity (mg/L)	99	112	106	141	124	135	169	161	156	133.66	25.19
11	Phosphate (mg/L)	0.081	0.091	0.093	0.066	0.072	0.071	0.043	0.051	0.039	0.067	0.019
12	Chloride (mg/L)	11.45	14.75	12.86	10.45	8.67	7.94	6.21	5.98	5.12	9.27	3.32
13	Nitrite (mg/L)	0.41	0.19	0.29	0.12	0.08	0.12	0.01	0.05	0.04	0.14	0.13
14	Nitrate (mg/L)	1.09	1.13	1.11	0.78	0.96	0.82	0.49	0.52	0.61	0.83	0.25
15	Sulphate (mg/L)	3.9	4.1	3.5	2.9	3.1	2.8	1.2	1.8	1.5	2.75	1.04
16	Potassium (mg/L)	1.11	1.32	1.25	0.27	0.37	0.31	0.69	0.95	0.82	0.78	0.40
17	Magnesium (mg/L)	7.96	8.22	6.58	11.11	10.78	9.12	13.54	12.45	14.78	10.50	2.75

Discussion

Bacillariophyceae and Chlorophyceae predominate in the Girna River ecosystem, which is consistent with research from comparable freshwater river systems in Maharashtra's semi-arid areas. Diatoms are commonly found in moderately clean, oxygen-rich waters and are well-known indicators of water quality.

On the other hand, the presence of pollution-tolerant Cyanophycean and Euglenophycean species at downstream locations suggests that human activity is causing ecological stress. The study's seasonal variations provide additional evidence that algal dynamics are strongly influenced by temperature, water flow, and nutrient availability.

Overall, the findings indicate that, despite localized effects of organic pollution, the Girna River in Malegaon tehsil retains a moderate level of algal diversity. The study emphasizes the significance of ongoing biomonitoring for sustainable river management and offers baseline ecological data.

Conclusion

The current investigation of the Girna River's algal diversity in Malegaon tehsil, Nashik district, Maharashtra, found a moderately abundant and ecologically significant algal flora. Throughout the study period, 57 species from the Chlorophyceae, Bacillariophyceae, Cyanophyceae, and Euglenophyceae groups were identified.

It was discovered that the dominant groups were Chlorophyceae (green algae) & Bacillariophyceae (diatoms) and especially at upstream and less disturbed sites, suggesting comparatively good water quality conditions. Pollution-tolerant genera like *Oscillatoria* and *Euglena*, however, are found downstream, indicating moderate organic pollution from human activities like sewage discharge and agricultural runoff.

There was clear seasonal variation, with the summer and winter seasons recording the highest diversity and the monsoon months showing the lowest diversity. The relationship between physicochemical parameters and algal distribution emphasizes how sensitive algal communities are to changes in their surroundings.

In general, the study provides baseline information on the algal diversity of the Girna River in the Malegaon region and highlights the necessity of consistent biomonitoring and efficient management techniques to preserve ecological balance and water quality.

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