

## Short Communication

### ASSESSMENT OF ALGAL DIVERSITY WITH SPECIFIC REFERENCE TO PHYSICO-CHEMICAL PARAMETERS IN THE PUN STREAM, KANGRA DISTRICT, HIMACHAL PRADESH

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#### Abstract

The present study evaluates algal diversity with specific reference to physico-chemical parameters of the Pun Stream in Kangra District, Himachal Pradesh, during post-monsoon and winter seasons. A total of 20 algal genera were recorded, representing Bacillariophyceae, Chlorophyceae, Cyanophyceae, and Euglenophyceae. Bacillariophyceae formed the dominant group in both seasons, with *Synedra spp.* and *Fragilaria spp.* showing consistently high abundance in post-monsoon, whereas *Cymbella spp.* appeared exclusively in winter. Physico-chemical analysis revealed a decline in temperature (24.6 °C to 19.8 °C) and a slight rise in pH (7.8 to 8.1) from post-monsoon to winter. TDS and EC increased moderately, indicating higher ion concentration due to reduced flow, while DO (6.9–7.2 mg/L) increased in winter, reflecting enhanced oxygen solubility at lower temperatures. Total hardness, calcium, and magnesium concentrations were relatively high and slightly higher in winter, indicating mineral enrichment. Higher algal diversity during post-monsoon was attributed to favourable temperature, moderate ionic concentration, and nutrient availability, whereas winter showed a shift towards tolerant genera adapted to cooler and more alkaline conditions. The study highlights the strong linkage between water quality parameters and algal community composition and provides baseline data for monitoring the ecological health of Himalayan streams.

**Keywords:** Algal Diversity, Parameters, Physico-chemical, Seasons.

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#### Introduction

Algae are among the most diverse groups of all living organisms. According to Rathod *et. al.*(2008), algae are generally aquatic and can be found in both fresh and salt water. They live in a variety of environments, such as rivers, lakes, ponds, and the

ocean (Rathod et al., 2024). The Pun Stream, avital component of the aquatic land scape in the Kangra district of Himachal Pradesh, India, sustains diverse ecosystems and supports numerous forms of life. Among them triad organisms in habiting its waters, algae hold particular significance due to the irpivotal role in nutrient cycling, oxygen production, and overall ecosystem functioning (Arora et al., 2018). Understanding the intricate relationship between algal diversity and physicochemical parameter sis essential for comprehensively assessing the ecological health of the Pun stream and formulating effective management strategies (Diwate et al., 2025). Algae, encompassing abroad spectrum of photosynthetic organisms ranging from microscopic di-atomstomacrosopic sea weeds, exhibit remarkable adaptability to various environmental conditions (Papadopoulou et al., 2025). Their distribution, abundance, and community composition are influenced by a multitude of factors, including water temperature, pH, dissolved oxygen (DO) levels, nutrient availability, light intensity, and sedimentation rates (Vajravelu et al., 2018). Consequently, alterations in the sephysico-chemical parameters can significantly impact algal populations, leading to shifts in community structure and ecosystem dynamics (Kumar & Thomas, 2019). Anthropogenic pressures such as agricultural runoff, industrial discharge, urbanisation, and deforestation can introduce pollutants and disrupt natural hydrological processes in the Pun stream, as they do in many other freshwater bodies (Akhtar et al., 2021). These disturbances may alter physico-chemical conditions within the stream, potentially exerting profound effects on algal diversity and overall ecosystem health (Chakraborty & Chakraborty, 2021; Siddiqui et al., 2025). Research focusing on algal diversity in the Pun stream provides valuable insights into the ecological status of this aquatic habitat and aids in identifying potential stress or sand pollution sources (Machuca-Sepúlveda et al., 2023; Wu et al., 2017). By conducting comprehensive surveys and analyses, researchers can discern patterns of algal distribution, assess water quality parameters, and evaluate ecosystem responses to environmental perturbations (Devi et al., 2016; Stevenson & Rollins, 2017). By advancing our understanding of algal diversity dynamics and their interactions with physico-chemical parameters, this study seeks to contribute to evidence-based decision-making processes for the protection and restoration of fresh water ecosystems in the Kangra district and beyond (Vajravelu et al., 2018). A perusal of the literature has revealed that very little information is available on the algal flora of the Kangra district of Himachal Pradesh.

## Materials and Methods

### Study Area

It is located between longitude 77°34'16.2012" East and latitude32°5'3. 1416" North. The state is situated in India's Himalayan region. It contains 12 districts and a total size of 55,673 square Kilometres, or around 1.69% of all of India. Kangra district lies between 31° 21' to 32° 59' N latitude and 75° 47' 55" to 77° 45' E longitude. The district spans a diverse range of altitudes, extending from the Shivalik hills through the Dhauladhar range to the Himalayas, running from northwest to southeast.

### Pun Stream

Pun Stream is Binnu Khad's right bank tributary. It is located between latitude 32.044682° North and longitude76.62223° East.

### Algal Sample Collection

In the Kangra district, algae samples were taken from the Pun stream. Forceps and needles were used to gather samples. To prevent contamination, allalgal samples were stored

in poly carbonate bottles containing a 4% formalin solution (Kaushik, 1987). There was less chance of contamination because fresh samples were used. After being transferred to the lab, fresh algae samples were obtained and put in petri plates. Apply one or two drops of glycerol to a glass slide. Next, use a forceps and needle to transfer a little amount of sample on to the glycerol. Finally, cover the glycerol with a cover slip. Under a microscope, the samples were inspected and identified using accepted references.

### Water Sample Analysis

Standard procedures were used to conduct physico-chemical examinations on water samples (Association, 1926)(Kaushik, 1987). Water samples from the Pun stream were collected for physico-chemical examination. Using a water testing meter, temperature, pH, TDS, and electrical conductivity were recorded immediately (Singhet al.2013). Titration was used to quantify the samples' total hardness, hardness resulting from  $\text{Ca}^{2+}$ , and hardness resulting from  $\text{Mg}^{2+}$  following (Association, 1926). Titration of water sampling was done with the help of the Indian Standard method of water testing.

### Results and Discussion

#### Algal Diversity in the Pun Stream

A total of 20 algal genera were identified, belonging to four major classes: Bacillariophyceae, Chlorophyceae, Cyanophyceae, and Euglenophyceae. Bacillariophyceae (diatoms) formed the dominant group in both seasons, with *Synedra* spp. and *Fragilaria* spp. showing consistently high (++) abundance) during post-monsoon, whereas *Cymbella* spp. appeared exclusively in winter. The reduction of *Gomphonema* spp. in winter suggests a preference for higher temperatures and nutrient availability, which are typically found during the post-monsoon period. Diatoms are well-known indicators of water quality, and their sustained presence reflects the good ecological status of the stream (Rana et al., 2022).

Chlorophyceae displayed a marked seasonal shift. *Chlamydomonas* spp., *Oedogonium* spp., and *Stigeoclonium* spp. were abundant in the post-monsoon but absent in winter, indicating their preference for warmer temperatures and higher light availability. In contrast, *Chlorella* spp., *Scenedesmus* spp., and *Oedogonium* spp. showed higher abundance in winter, suggesting that certain green algae can tolerate low temperatures and thrive under relatively stable physicochemical conditions (Kumar et al., 2022; Kumari & Sharma, 2018).

Cyanophyceae (blue-green algae) were represented by five genera. *Anabaena* and *Merismopedia* spp. were abundant during post-monsoon, coinciding with higher nutrient concentrations that may promote nitrogen-fixing cyanobacteria (Li et al., 2022). *Chroococcus* spp. and *Calothrix* spp. were more prominent in winter, which could be linked to their ability to survive in low-light and cooler conditions (Minor et al., 2019). *Microcystis* spp. maintained a high presence in both seasons, indicating its adaptability and potential to form blooms under suitable conditions (Narasimha & Benarjee, 2013).

Euglenophyceae were relatively less diverse but exhibited a significant seasonal shift. *Euglena* spp. and *Phacus* spp. showed higher abundance in winter, possibly benefiting from increased organic matter accumulation and slightly alkaline conditions observed in the physico-chemical analysis (pH 8.1).

#### Seasonal Patterns and Ecological Implications

Overall, algal diversity was higher in the post-monsoon season, as indicated by a greater number of genera showing "++" abundance. This trend can be attributed to favourable physico-chemical conditions such as warmer temperature (24.6 °C), lower ionic

concentration, and moderate nutrient availability, which collectively support higher primary productivity. In contrast, winter was characterized by a shift towards tolerant genera such as *Cymbella*, *Chlorella*, *Scenedesmus*, *Chroococcus*, and euglenoids, reflecting adaptation to cooler temperatures (19.8 °C), higher hardness, and slightly alkaline pH.

The observed seasonal turnover highlights the role of temperature, nutrient availability, and light conditions in shaping algal community structure. The dominance of diatoms and the presence of multiple Chlorophyceae and Cyanophyceae genera suggest a well-oxygenated, nutrient-moderate stream ecosystem, indicating relatively healthy water quality.

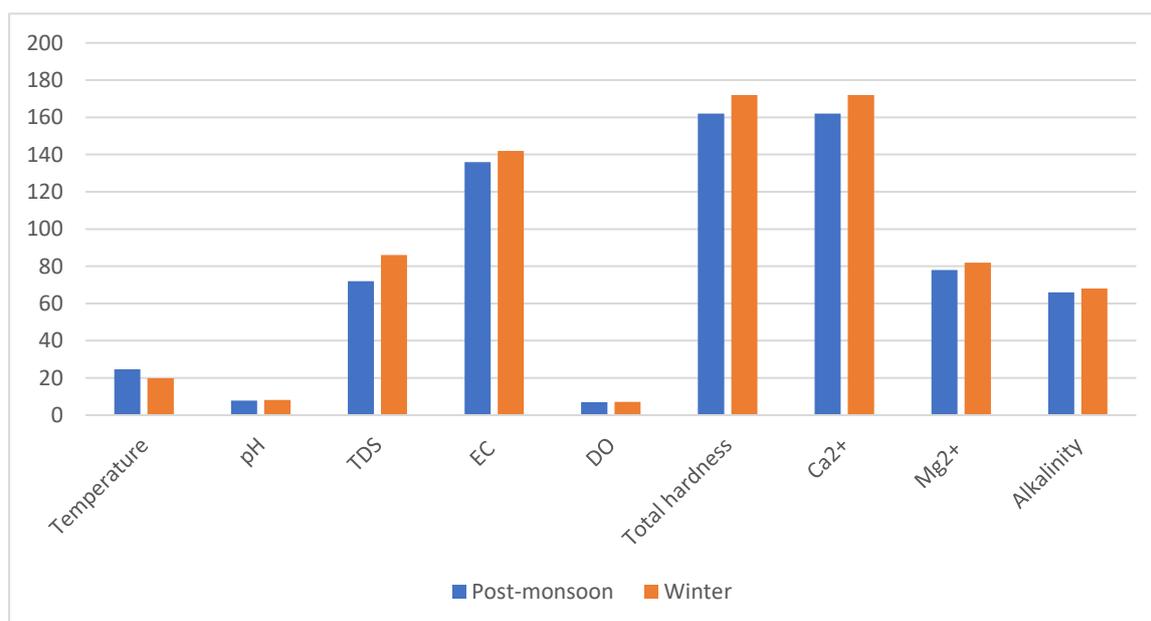
**Table 1.** Summarizes the Occurrence and Relative Abundance of Algal Genera Recorded During the Post-Monsoon and Winter Seasons.

Sr.no.	Name of Algal Genera	Post-monsoon	Winter
<b>Class: Bacillariophyceae</b>			
1.	<i>Amphora spp.</i>	+	+
2.	<i>Cymbella spp.</i>	-	+
3.	<i>Fragilaria spp.</i>	++	+
4.	<i>Gomphonemaspp.</i>	++	-
5.	<i>Synedra spp.</i>	++	++
<b>Class: Chlorophyceae</b>			
6.	<i>Chlamydomonas spp.</i>	++	-
7.	<i>Chlorella spp.</i>	+	++
8.	<i>Hydrodictyon spp.</i>	++	-
9.	<i>Oedogonium spp.</i>	++	-
10.	<i>Scenedesmus spp.</i>	+	++
11.	<i>Stigeoclonium spp.</i>	++	-
12.	<i>Oedogonium spp.</i>	-	++
<b>Class: Cyanophyceae</b>			
14.	<i>Anabaena</i>	++	+
15.	<i>Calothrix</i>	-	+
16.	<i>Chroococcuspp.</i>	+	++
17.	<i>Merismopedia spp.</i>	++	-
18.	<i>Microcystisspp.</i>	++	++
<b>Class: Euglenophyceae</b>			
19.	<i>Euglena spp.</i>	+	++
20.	<i>Phacus spp.</i>	+	++

Table 2 presents the seasonal variation in physico-chemical parameters of the Pun Stream during the post-monsoon and winter seasons. Temperature exhibited a marked seasonal decline from 24.6 °C in the post-monsoon to 19.8 °C in winter, reflecting the influence of low ambient air temperature and reduced solar radiation during the colder months. Similar seasonal patterns have been reported in other Himalayan streams, where temperature is a key determinant of biological activity and nutrient cycling(Ahmad & Hasnain, 2001; Kumar *et al.*, 2022). pH values ranged from 7.8 (post-monsoon) to 8.1 (winter), indicating slightly alkaline conditions throughout the study period. A marginal rise in pH during winter may be attributed to lower rates of organic matter decomposition and reduced carbon dioxide levels due to decreased microbial respiration(Minor *et al.*, 2019).

**Table 2.** Physico-chemical Parameters of Pun stream

Sr. no.	Parameters	Post-monsoon	Winter
1.	Temperature	24.6°C	19.8°C
2.	pH	7.8	8.1
3.	TDS	72	86
4.	EC	136	142
5.	DO	6.9	7.2
6.	Total hardness	162	172
7.	Ca <sup>2+</sup>	162	172
8.	Mg <sup>2+</sup>	78	82
9.	Alkalinity	66	68



**Fig 1.** Physico-chemical Parameters of Pun Stream

TDS and EC values showed a moderate increase from 72 mg/L and 136  $\mu$ S/cm in the post-monsoon to 86 mg/L and 142  $\mu$ S/cm in winter, respectively. This rise could be linked to lower stream discharge during winter, resulting in higher ion concentration due to reduced dilution (Ahmad & Hasnain, 2001). Similar trends have been reported in streams of the Western Himalaya (Bhat *et al.*, 2016). Dissolved oxygen (DO) levels ranged from 6.9 mg/L in the post-monsoon to 7.2 mg/L in winter. Total hardness, calcium, and magnesium concentrations were found to be relatively high, characteristic of the region's geology,

dominated by limestone and other calcium-rich rocks (Parvateesam & Mishra, 1993). Total hardness increased slightly from 162 mg/L in the post-monsoon to 172 mg/L in winter, while calcium and magnesium concentrations increased from 78 mg/L and 84 mg/L to 82 mg/L and 92 mg/L, respectively. These results suggest increased mineral leaching and reduced water flow, leading to higher ion accumulation during the winter months (Patil *et al.*, 2012; Sharma & Kumar, 2017). Alkalinity showed minimal seasonal variation (66–68 mg/L), reflecting the stable bicarbonate buffering capacity of the stream water. This stability is essential for maintaining pH within a narrow range, which is favourable for algal growth and other aquatic biota (Pokhrel *et al.*, 2021). Overall, the physico-chemical profile of the Pun Stream indicates good water quality with slightly alkaline, moderately hard water and adequate oxygenation. The observed seasonal variations are consistent with typical lotic ecosystems, where temperature and discharge play major roles in modulating water chemistry and, consequently, algal diversity and productivity (Patil *et al.*, 2012).

### Conclusion

The present study highlights the seasonal variation in algal diversity and its close relationship with the physico-chemical characteristics of the Pun Stream in Kangra District, Himachal Pradesh. A total of 20 algal genera, representing four major classes, were recorded, with Bacillariophyceae emerging as the dominant group across both seasons. Post-monsoon season supported higher algal richness and abundance, which can be attributed to warmer temperatures, moderate nutrient levels, and favorable light conditions that enhance primary productivity. In contrast, winter was characterized by a shift towards tolerant genera such as Cymbella, Chlorella, Scenedesmus, Chroococcus, and euglenoids, reflecting their adaptability to lower temperatures, slightly alkaline pH, and increased ionic concentration. The physico-chemical analysis revealed that temperature, pH, hardness, and dissolved oxygen are key drivers influencing algal community structure. The overall water quality of the Pun Stream was found to be good, with slightly alkaline, moderately hard water and sufficient oxygenation, supporting a diverse algal community. These findings provide baseline data for understanding the ecological status of the Pun Stream and can be used for future biomonitoring programs and conservation planning in Himalayan freshwater ecosystems. Continuous monitoring is recommended to track changes caused by anthropogenic pressure or climate variability.

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