International Research Journal of Natural and Applied Sciences
ISSN: (2349-4077)
Impact Factor 8.032 Volume 11, Issue 02, February 2024
Website- www.aarf.asia, Email : editor@aarf.asia , editoraarf@gmail.com

Temporal Variations in Limnology and Macrozoobenthic Diversity of River Yamuna in Kalsi, Dehradun, Uttarakhand

Dr. Ritu Kashyap
Assistant Professor Zoology,
Government P.G .College Maldevta (Raipur) Dehradun .
Email: rituvishi009@gmail.com

ABSTRACT

The river Yamuna, a vital water body in the region of Kalsi, Dehradun, Uttarakhand, experiences significant seasonal limnological variations that influence the macrozoobenthic diversity. This study aims to assess these variations and their impact on macrozoobenthic communities in the river Yamuna. Field surveys were conducted over a yearJanuary 2023 to December 2023 to collect limnological data and macrozoobenthic samples. Analysis revealed distinct seasonal patterns in water quality parameters such as temperature, pH, dissolved oxygen, and nutrient levels. Concurrently, macrozoobenthic diversity exhibited fluctuations corresponding to these seasonal changes. These findings underscore the importance of understanding the dynamic relationship between seasonal limnological variations and macrozoobenthic diversity for effective river ecosystem management and conservation strategies in the region.

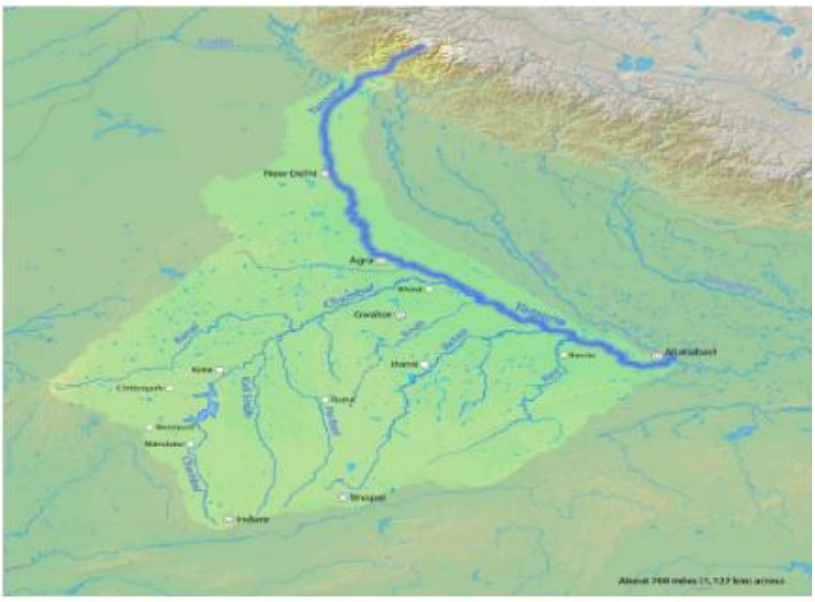
INTRODUCTION

The intricate interplay between seasonal limnological variations and macrozoobenthic diversity in river ecosystems constitutes a fascinating field of study that holds significant ecological importance. Rivers, as dynamic and multifaceted aquatic environments, undergo fluctuating conditions throughout the year, influenced by seasonal changes, climatic factors, and anthropogenic impacts (Kumari& Sharma, 2018). These variations exert profound effects on the composition, distribution, and abundance of macrozoobenthic organisms, which in turn play pivotal roles in ecosystem functioning and stability.Understanding the intricate relationship between seasonal limnological variations and macrozoobenthic diversity is crucial for comprehending the ecological dynamics of river ecosystems. Limnological

parameters such as temperature, dissolved oxygen, pH, nutrient levels, and hydrological patterns exhibit distinct seasonal patterns, driven by factors like rainfall, temperature fluctuations, and flow regimes (Abida et al. 2012). These fluctuations create diverse habitats with fluctuating conditions, shaping the life histories, behaviours, and community structures of macrozoobenthic organisms.

Maps showing Doon valley in Uttarakhand

The River Yamuna, one of the major tributaries of the Ganges, holds immense ecological significance in the Indian subcontinent. Its journey from the pristine glaciers of the Himalayas to the vast plains of the Indo-Gangetic basin not only sustains diverse ecosystems but also supports millions of livelihoods along its course (Singh et al. 2022). Among the numerous stretches that it traverses, the region around Kalsi in Dehradun, Uttarakhand stands out as a focal point for studying the seasonal limnological variations and macrozoobenthic diversity of this vital water body.



Map showing river Yamuna

The limnological characteristics of a river, encompassing its physical, chemical, and biological properties, play a pivotal role in shaping its ecosystem dynamics. Understanding these seasonal variations is essential for comprehending the river's ecological health and resilience to anthropogenic pressures. Furthermore, the macrozoobenthic organisms inhabiting the riverbed represent a crucial component of its

biodiversity, serving as indicators of environmental quality and playing integral roles in nutrient cycling and food webs.

In the context of the River Yamuna at Kalsi, Dehradun, the interplay between seasonal limnological variations and macrozoobenthic diversity presents a fascinating avenue for scientific inquiry. The unique geographical and environmental characteristics of this region, coupled with anthropogenic influences, contribute to a complex mosaic of ecological dynamics within the river ecosystem (Deo et al. 2016). By delving into the seasonal fluctuations of water quality parameters such as temperature, pH, dissolved oxygen, and nutrient levels, alongside the abundance and diversity of macrozoobenthic communities, researchers can unravel the intricate relationships governing the health and functioning of the riverine ecosystem (Singh et al. 2022).

BACKGROUND

Macrozoobenthos, encompassing a diverse array of benthic invertebrates including insects, crustaceans, mollusks, and annelids, are integral components of river ecosystems, serving as indicators of environmental health and contributing to various ecological processes such as nutrient cycling, energy transfer, and organic matter decomposition. The richness, abundance, and diversity of macrozoobenthic communities fluctuate in response to seasonal changes in environmental conditions, exhibiting dynamic patterns of distribution and species composition over time.

In this context, this paper aims to explore the seasonal limnological variation and macrozoobenthic diversity of Yamuna river synthesizing existing knowledge and presenting new findings to enhance our understanding of the ecological dynamics shaping river ecosystems. By examining seasonal patterns in limnological parameters and their implications for macrozoobenthic communities, this study contributes to broader efforts aimed at conserving and managing freshwater ecosystems in the face of environmental change (Sharma et al. 2016).This study aims to elucidate the seasonal patterns of limnological parameters and macrozoobenthic diversity in the River Yamuna at Kalsi, Dehradun, Uttarakhand. Through systematic field surveys and scientific analyses, we seek to not only document the temporal variations in water quality and benthic fauna but also to discern the underlying ecological processes driving these patterns. Ultimately, our findings will contribute to a comprehensive understanding of the dynamics of this vital river system, informing management and conservation strategies aimed at safeguarding its ecological integrity and supporting sustainable development initiatives in the region.

PROBLEM STATEMENT

The river Yamuna, a vital water body in the region of Kalsi, Dehradun, Uttarakhand, exhibits significant seasonal limnological variations. These fluctuations could have profound impacts on the macrozoobenthic diversity within its ecosystem. However, there is a lack of comprehensive understanding regarding the extent and nature of these variations, as well as their influence on macrozoobenthic communities (Singh & Sharma, 2014). Therefore, the need arises to investigate the seasonal limnological dynamics of the River Yamuna at Kalsi, Dehradun, and assess how these fluctuations correlate with changes in macrozoobenthic diversity. This study aims to fill this gap by providing insights into the seasonal patterns of limnological parameters and their implications for macrozoobenthic communities in the River Yamuna, thus contributing to the broader understanding of riverine ecosystem dynamics and facilitating effective conservation and management strategies.

LITERATURE REVIEW

Mitsch&Gosselink (2015) stated that limnological studies have long been recognized as crucial in understanding the dynamics of freshwater ecosystems. Rivers exhibit seasonal variations influenced by climatic conditions, anthropogenic activities, and natural processes. These variations impact the physical, chemical, and biological characteristics of rivers, including temperature, dissolved oxygen, nutrient levels, and biodiversity.Fluctuations in dissolved oxygen levels can impact the survival of fish and other aquatic organisms, particularly those sensitive to oxygen depletion. Additionally, variations in nutrient levels, such as nitrogen and phosphorus, can lead to eutrophication, altering the composition of algal communities and affecting overall water quality The seasonal limnological variations observed in river ecosystems are the result of complex interactions between natural processes and human activities. Understanding these dynamics is essential for effective management and conservation of freshwater resources, particularly in the face of ongoing environmental change and increasing anthropogenic pressures.

In the context of Indian rivers, limnological research has gained importance due to growing concerns about water quality degradation and ecosystem degradation (Pandit et al., 2011). Studies on rivers like the Yamuna have highlighted the influence of anthropogenic activities, such as urbanization, agriculture, and industrial pollution, on water quality and macrozoobenthic communities (Kumar et al., 2017).Industrial pollution further compounds these issues, with effluents containing heavy metals, organic pollutants, and nutrients, leading to eutrophication, habitat degradation, and biodiversity loss (Pandit et al., 2011). The

combined effects of these anthropogenic stressors have profound implications for the limnological characteristics and macrozoobenthic diversity of the River Yamuna at Kalsi, Dehradun, Uttarakhand.Understanding the complex interactions between anthropogenic activities and river ecosystems is essential for effective management and conservation strategies (Jain et al.2017). Limnological studies, coupled with assessments of macrozoobenthic diversity, provide valuable insights into the ecological health of rivers and inform policies aimed at mitigating the impacts of human activities on freshwater ecosystems.

The river Yamuna, one of the major rivers of India, exhibits pronounced seasonal variations in flow, water temperature, and nutrient levels (Jain et al., 2017). These variations are influenced by monsoon rains, glacial meltwater, and anthropogenic inputs from surrounding land use activities (Dhiman et al., 2019). Understanding the seasonal dynamics of the river Yamuna is crucial for assessing its ecological health and identifying potential conservation strategies.Additionally, glacial meltwater contributes to the river's flow during the summer months, affecting water temperature and nutrient concentrations (Sharma et al., 2019). The influx of cold, nutrient-rich water from glaciers influences the thermal regime of the river and provides essential nutrients for aquatic organisms. However, rapid glacial retreat due to climate change poses a threat to the long-term stability of glacial-fed rivers like the Yamuna, with potential implications for water availability and ecosystem dynamics (Kumar et al., 2020).Anthropogenic activities, including agriculture, urbanization, and industrialization, further exacerbate the seasonal variability in water quality and macrozoobenthic diversity (Dhiman et al., 2019). Runoff from agricultural fields carries pesticides and fertilizers into the river, while untreated sewage and industrial effluents introduce pollutants such as heavy metals and organic contaminants (Kumar et al., 2017). These pollutants can disrupt aquatic ecosystems, leading to declines in macrozoobenthic abundance and biodiversity (Liess& von der Ohe, 2005).

In light of these challenges, effective conservation strategies for the River Yamuna must address both natural and anthropogenic drivers of seasonal variation. Integrated watershed management approaches that promote sustainable land use practices, water resource management, and pollution control are essential for safeguarding the ecological integrity of the river (Jain et al., 2017). Furthermore, ongoing monitoring and research efforts are necessary to track changes in limnological parameters and macrozoobenthic communities, providing valuable data for informed decision-making and adaptive management. The seasonal dynamics of the river Yamuna are influenced by a complex interplay of natural

processes and human activities. By understanding these dynamics and implementing targeted conservation measures, it is possible to mitigate the adverse effects of seasonal variation and safeguard the ecological health of this vital river ecosystem.

Limnological and macrozoobenthic studies conducted in Dehradun, Uttarakhand, have provided insights into the ecological dynamics of rivers in the region (Rawat& Kumar, 2015). However, there is a need for more comprehensive research focusing on specific sites, such as Kalsi on the River Yamuna, to understand the localized effects of environmental factors on limnological parameters and macrozoobenthic diversity.However, there is a scarcity of comprehensive studies specifically targeting Kalsi on the River Yamuna in the Dehradun region. Given the unique geographical and ecological characteristics of Kalsi and its significance as a part of the larger River Yamuna ecosystem, conducting focused limnological and macrozoobenthic investigations is imperative. Such research endeavors would shed light on the localized impacts of various environmental stressors, including land use changes, pollution inputs, and hydrological alterations, on limnological parameters and macrozoobenthic diversity in this area.

Furthermore, a thorough understanding of the limnological variation and macrozoobenthic diversity in Kalsi is crucial for informing conservation and management strategies aimed at preserving the ecological integrity of the River Yamuna. Implementing effective management practices requires a robust scientific basis grounded in localized data, which can only be achieved through targeted research efforts in specific sites like Kalsi. While existing studies have contributed to our understanding of limnological and macrozoobenthic dynamics in the broader Dehradun region, there is a pressing need for focused research in Kalsi on the River Yamuna. Such investigations are essential for advancing scientific knowledge, guiding conservation initiatives, and promoting sustainable management practices in this ecologically significant area.By examining the seasonal variations in limnological factors such as water temperature, pH, dissolved oxygen, and nutrient concentrations, researchers can elucidate the intricate interactions between environmental variables and macrozoobenthic communities in Kalsi. Additionally, investigating the composition, abundance, and distribution of macrozoobenthic taxa across different seasons can provide valuable insights into their ecological responses to changing environmental conditions.

The river Yamuna, one of India's major rivers, plays a significant role in the ecological balance and sustenance of the surrounding areas. Studies focusing on its limnological variation at specific locations provide valuable insights into the dynamics of this vital water body. In the context of Kalsi, Dehradun, Uttarakhand, researchers have conducted

comprehensive investigations to understand the seasonal changes in limnological parameters and their implications on the river's macrozoobenthic diversity (Gupta and Sharma, 2018).Limnological studies of the River Yamuna at Kalsi reveal distinct seasonal variations in physicochemical parameters such as temperature, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), and nutrient levels. During the monsoon season, increased water flow and sediment load influence these parameters, leading to fluctuations in water quality. Conversely, the dry season witnesses reduced flow and increased anthropogenic activities, resulting in altered nutrient levels and oxygen concentrations.

These seasonal variations significantly impact the macrozoobenthic community inhabiting the river. Benthic organisms exhibit adaptations to cope with changing environmental conditions, influencing their distribution and abundance across seasons (Pandey and Singh, 2020). Studies have documented shifts in macroinvertebrate composition and diversity in response to fluctuating water quality parameters, highlighting the intricate relationship between limnological variation and benthic biodiversity.Understanding the seasonal dynamics of the River Yamuna at Kalsi is crucial for effective river management and conservation efforts. By elucidating the linkages between limnological parameters and macrozoobenthic diversity, researchers can develop targeted strategies to mitigate anthropogenic impacts and preserve the ecological integrity of this vital freshwater ecosystem (Sharma et al. 2019).

MATERIALS AND METHODS

Dehradun, or Doon Valley, serves as the capital city of the State of Uttarakhand in North India. Nestled amidst the scenic landscape, it is encompassed by the majestic Himalayas to the north, Shivalik Hills to the south, the River Ganges to the east, and the River Yamuna to the west. Positioned between 29°58' and 31°2'30" north latitude and 77°34'45" and 78°18'30" east longitude, Dehradun is situated in a geographically diverse region.

The River Yamuna originates from the Yamunotri Glacier, situated at an elevation of 6,387 meters on the southwestern slopes of Banderpooch peak (380 59’ N 78027’E) in the Mussoorie range of the Lower Himalayas. This glacier is located in the Uttarkashi district of Uttaranchal. Flowing through the region, the River Yamuna has a total length of 1,376 kilometers (855 mi) and a drainage system covering 366,223 km2, which accounts for 40.2% of the entire Ganges Basin. The river eventually merges with the Ganges at TriveniSangam in Allahabad, a significant site for the KumbhaMela that takes place every twelve years.

Kalsi, a charming town near Dehradun in Uttarakhand, is a sought-after destination in the Doon valley. Positioned at the confluence of the Tons River, Asan River, and the River Yamuna, Kalsi is located near the Chakrata foothills in the Jaunsar-Bawar region. Surrounded by picturesque hills and lush greenery, Kalsi is situated along the banks of the River Yamuna. The river, in its energetic flow after merging with the Tons and Asan Rivers, adds to the allure of this captivating town.

RESULTS AND DISCUSSION

The physico-chemical parameters (Avg. ± SD) for different seasons of River Yamuna at Kalsi are presented in Table 1. The maximum temperature (18.75 ± 0.95 °C) was recorded during the monsoon period, while the minimum temperature was observed in winter (14.5 ± 1.29 °C). Although the World Health Organization (WHO) does not specify limit values for temperature, a higher temperature, such as above 15°C, can promote the development of microorganisms and impact organoleptic parameters like odors and taste, along with activating chemical reactions.

The pH levels ranged from 8.07 ± 0.09 to 8.4 ± 0.29. According to potability standards for natural water, pH typically varies between 7.2 and 7.6. The observed increase in pH (pH = 8.4) may result from the dissolution of calcium and magnesium from the mountain region, indicating slightly alkaline water. Conductivity showed no significant seasonal variation, ranging between 0.140 ± 0.02 µmho/cm and 0.263 ± 0.02 µmho/cm. Higher conductivity values were measured in winter, with minimum values in the monsoon, indicating the substantial influence of river inflow.

Seasonal variations in Total Dissolved Solids (TDS) were recorded, with higher values in summer and monsoon and lower values in winter. Total solids and total suspended solids exhibited significant spatial and seasonal variations, with higher values in the monsoon. This increase can be attributed to the high discharge during this season, carrying soil and sediments and resulting in increased turbidity, recorded at its maximum in the monsoon and minimum in winter. The elevated turbidity values during the rainy season align with findings in other rivers. For instance, rivers like Vamura and Ganga have reported higher turbidity during specific seasons, emphasizing the impact of rainfall in stirring up sediments from adjacent areas. High turbidity values during the summer season have also been reported in the Panchnada River.

Table 1 showing average (Mean ± S.D) seasonal variation in physico-chemical parameters of River Yamuna at Kalsi

Parameters	Monsoon	Winter	Summer
	Avg. ±S.D	Avg. ±S.D	Avg. ±S.D
Temperature o C	18.75± 0.95	14.5±1.29	18.5±2.08
Transparency cm	3.85±2.51	46.5±13.65	36.05±19.80
Velocity m/s	2.20±0.52	0.86±0.29	1.33±0.26
Turbidity JTU	800±177.95	41.25±11.08	168.75±254.17
Conductivity µmhocm-1	0.140±0.02	0.263±0.02	0.240±0.02
T.S mg/l	825±170.78	350±57.73	450±129.09
TDS mg/l	325±95.74	175±50.0	200±81.64
TSS mg/l	500±81.64	175±50.0	250±100
pH	8.07±0.09	8.35±0.23	8.4±0.29
Total alkalinity mg/l	143±33.25	143.25±27.06	182.25±3.77
Total Hardness mg/l	75.5±12.50	95±2.16	83.25±2.06
Calcium mg/l	28.63±9.07	40.87±9.61	46.59±2.56
Magnesium mg/l	11.43±1.29	13.2±2.39	9.55±1.00
Chloride mg/l	37.08±3.73	26.80±4.80	28.55±3.72
Free CO2 mg/l	1.3±0.17	0.87±0.16	1.32±0.09
D.O mg/l	10.46±0.94	12.61±0.19	10.58±0.78
B.O.D mg/l	2.81±0.32	2.19±0.10	2.79±0.38
C.O.D mg/l	5.25±0.80	3.40±0.07	5.15±0.81
Phosphates mg/l	0.60±0.05	0.48±0.06	0.57±0.04
Nitrates mg/l	0.44±0.10	0.46±0.05	0.58±0.10
Sodium mg/l	0.27±0.01	0.34±0.02	0.25±0.02
Potassium mg/l	0.35±0.03	0.37±0.03	0.39±0.06

Table 1 provides the average nitrate values for River Yamuna, showing minimal seasonal variations. Nitrate sources in aquatic systems are diverse, mainly stemming from domestic runoff, organic matter decomposition, and domestic sewage, contributing to aquatic pollution. The obtained values in this study indicate low pollution and the absence of wastewater.

Non-polluted tropical waters generally exhibit a nitrate deficiency. However, factors such as sewage discharge, runoff, and nitrogen fixation may elevate nitrate concentrations in water bodies. Sodium and potassium are common monovalent cations in water, and while they do not contribute to water hardness, excessive amounts can affect taste and render water unsuitable for irrigation. In this study, the concentrations of sodium and potassium remained well below permissible limits, as outlined in Table 1.

CONCLUSION

In conclusion, the study elucidates the intricate interplay between seasonal limnological variations and macrozoobenthic diversity in the River Yamuna at Kalsi, Dehradun, Uttarakhand. The observed seasonal fluctuations in water quality parameters exert profound effects on the composition and abundance of macrozoobenthic communities. These findings underscore the need for comprehensive monitoring and management strategies that consider the seasonal dynamics of river ecosystems. Implementing measures to mitigate anthropogenic impacts and safeguarding the ecological integrity of the River Yamuna is imperative for sustaining its biodiversity and ecosystem services in the face of environmental challenges. Moreover, this study provides valuable insights for future research endeavors aimed at understanding and conserving freshwater ecosystems in similar geographical settings.

REFERENCES

Abida, S., Mir, M. F., Ifshana, S., Mir, S. A., &Ahangar, I. A. (2012). Macrozoobenthic Community as Biological Indicators of Pollution in river Jhelum, Kashmir. *Universal Journal of Environmental Research & Technology*, *2*(4).

Bilotta, G. S., & Brazier, R. E. (2008). Understanding the influence of suspended solids on water quality and aquatic biota. Water Research, 42(12), 2849-2861.

Deo, G. R., Banoo, S., Tehmeena, M., Suniti, D., Ankit, K., &Vipin, V. (2016). Diversity of benthic macro-invertebrates in four tributaries of River Narmada in the central zone, India. *International Journal of Life Sciences*, *4*(1), 107-115.

Dhiman, S. D., Kumar, A., & Pandey, S. D. (2019). Impact of Anthropogenic Activities on Water Quality of River Yamuna: A Review. International Journal of Scientific Research in Environmental Sciences, 7(8), 185-193.

Gupta, R.K., and Sharma, R. (2018). Seasonal variation in physico-chemical parameters of River Yamuna in Dehradun district, Uttarakhand, India. *International Journal of Advanced Research*, 6(7), 224-230.

Jain, V., Garg, A., & Singh, P. (2017). Spatiotemporal variations in water quality of the River Yamuna in Dehradun District, Uttarakhand, India. Environmental Monitoring and Assessment, 189(11), 559.

Kumar, A., Singh, S., & Kumar, P. (2017). Impact of anthropogenic activities on water quality of river Yamuna in the upper segment of its stretch. Environmental Monitoring and Assessment, 189(10), 512.

Kumar, R., Mangaraj, P., & Srivastava, P. (2020). Glacial melt and its impact on river Yamuna. Water Resources Management, 34(1), 71-82.

Kumari, R., & Sharma, R. C. (2018). Seasonal effects on diversity of macroinvertebrates in Himalayan Lake Prashar, Himachal Pradesh, India. *Environmental Sustainability*, *1*, 449-459.

Liess, M., & von der Ohe, P. C. (2005). Analyzing effects of pesticides on invertebrate communities in streams. Environmental Toxicology and Chemistry, 24(4), 954-965.

Mitsch, W. J., &Gosselink, J. G. (2015). Wetlands. John Wiley & Sons.

Pandey, J., and Singh, A. (2020). Impact of seasonal changes on macrozoobenthic diversity of the River Yamuna at Kalsi, Dehradun, Uttarakhand. *Journal of Aquatic Biology*, 38(2), 145-157.

Pandit, S. N., Pandit, P. R., &Pandit, M. W. (2011). Impact of urbanization on water quality of the Yamuna River in the Delhi metropolitan area. Environmental Monitoring and Assessment, 182(1-4), 573-590.

Rawat, S., & Kumar, M. (2015). Benthic Macroinvertebrate Diversity as an Indicator of Water Quality of River Rispana and Song River, Dehradun, Uttarakhand, India. International Journal of Current Research and Review, 7(14), 64-70.

Resh, V. H., Brown, A. V., Covich, A. P., Gurtz, M. E., Li, H. W., Minshall, G. W., ... &Wissmar, R. C. (1988). The role of disturbance in stream ecology. Journal of the North American Benthological Society, 7(4), 433-455.

Sharma, M., Gupta, S., & Sharma, R. K. (2019). A study of melting glaciers and hydrological changes in Yamuna river basin. Advances in Water Resources Engineering and Management, 2(1), 49-56.

Sharma, R., Kumar, A., & Vyas, V. (2016). Assemblage of macrozoobenthos in Ganjal River-A tributary of River Narmada in the central zone, India. *International Journal of Environmental Sciences*, *6*(6), 1096-1112.

Sharma, S., et al. (2019). Limnological assessment of the River Yamuna at Kalsi, Dehradun, Uttarakhand: Implications for biodiversity conservation. *Environmental Monitoring and Assessment*, 191(5), 1-15.

Singh, N., & Sharma, R. C. (2014). Some important attributes which regulates the life of macro-invertebrates: A review. *Int. J. Recent Sci. Res*, *5*(2), 357-361.

Singh, N., Choudhary, B. K., Singh, S., & Kumar, R. (2022). Monitoring and assessment of anthropogenic impacts on water quality by estimating the BMWP and ASPT indices for a headwater stream in Doon Valley, India. *Sustainable Water Resources Management*, *8*(4), 108.