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OBSERVATION ON ECOLOGY AND DIVERSITY OF PERIPHYTON COMMUNITY IN THE MAL GAD STREAM FROM GARHWAL REGION, INDIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The current research focuses on the periphytic diversity of the Mal Gad stream in Uttarkashi, Uttarakhand, India. The coordinates of this spring-fed stream are Latitude: 30°52'38.25"N and Longitude: 78°4'11.49"E. During the investigation it was found that the periphytic algal diversity of Mal Gad stream was represented by 19 genera belonging to 3 major classes namely Bacillariophyceae (*Cymbella* sp*., Synedra* sp*., Navicula* sp*., Fragilaria* sp*., Gomphonema* sp*., Achnanthes* sp*., Bacillaria* sp*., Diatoma* sp*. and Tabellaria* sp*.*), Chlorophyceae (*Oedogonium* sp*., Spirogyra* sp*., Microspora* sp*., Volvox* sp*., Zygenema* sp*., Cladophora* sp*., Geminela* sp*., and Ulothrix* sp.) and Cyanophyceae (*Nostoc* sp*.* and *Rivularia* sp*,*). The present investigation will be helpful in enhancing the knowledge regarding the production potential of the water body. The dominance of Bacillariophyceae indicates the healthy ecological condition of the stream. Based on the study, the stream is found favorable for the culture of herbivorous snow-trout, *Schizothorax* sp. on a commercial scale.

Keywords: Periphyton diversity; spring-fed stream; ecology; Uttarkashi; Garhwal Himalaya.

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1. INTRODUCTION

Periphyton is an aggregate of organisms attached to solid substrates in benthic habitats, including algae, bacteria, protozoa and invertebrates attached to submerged substrata in almost all aquatic ecosystems [1]. These have a definite role in the food chain. Their distribution and abundance vary seasonally and spatially due to multiple factors and are potentially influenced by light, temperature, current, substrate, and the scouring effects of floods, water chemistry and grazing. Diatom typically comprises the majority of species within the periphyton, although blue and green algae and cyanobacteria are well represented and can dominate the biomass of the benthic autotrophs under some circumstances [2]. Periphyton in streams and rivers are important components of aquatic ecosystems providing food for aquatic organisms in the local and downstream ecosystem [3].

Periphyton and phytoplankton species are useful indicators of nutrient enrichment composition and growth [4-9]. Water quality indicators include periphyton, phytoplankton, fish, macroinvertebrates, amphibians, macrophytes, fecal coliforms, and total coliforms [4,10-13]. Biological indicators are described as organisms that show variations with changes in water quality parameters. Periphyton communities commonly prefer littoral areas of aquatic ecosystems owing to the easy availability of hard surfaces and sunlight. However, this feature makes them vulnerable as they are exposed to contaminants that originate from the land. These anthropogenic contaminants may include industrial effluents and suspended sediments that include nutrients and other contaminants [14].

The ecosystem significance and role of periphyton communities have received the attention of many workers [15-21]. Fragmentary studies involving periphyton density and diversity development based on riparian vegetation [22,23], stream physicochemical parameters as well as the effect of periphyton density and diversity on the occurrence of several mites and macrozoobenthos density [24-56] have been done. The present study is based on the periphyton community of the Mal Gad stream in Uttarkashi, Uttarakhand, India.

2. MATERIALS AND METHODS

2.1 Sampling Area

The current study was carried out for the period of one year from May 2020 to April 2021. One sampling site on each of the 1st order and 2nd order streams of the Mal Gad was identified at a distance of around 09km [57]. The sampling sites were located near Kufara Gaon (Latitude: 30°53'21.14"N and Longitude: 78°1'18.85"E) and Kurara Gaon (Latitude: 30°52'38.25"N and Longitude: 78°4'11.49"E) respectively (Fig. 1).

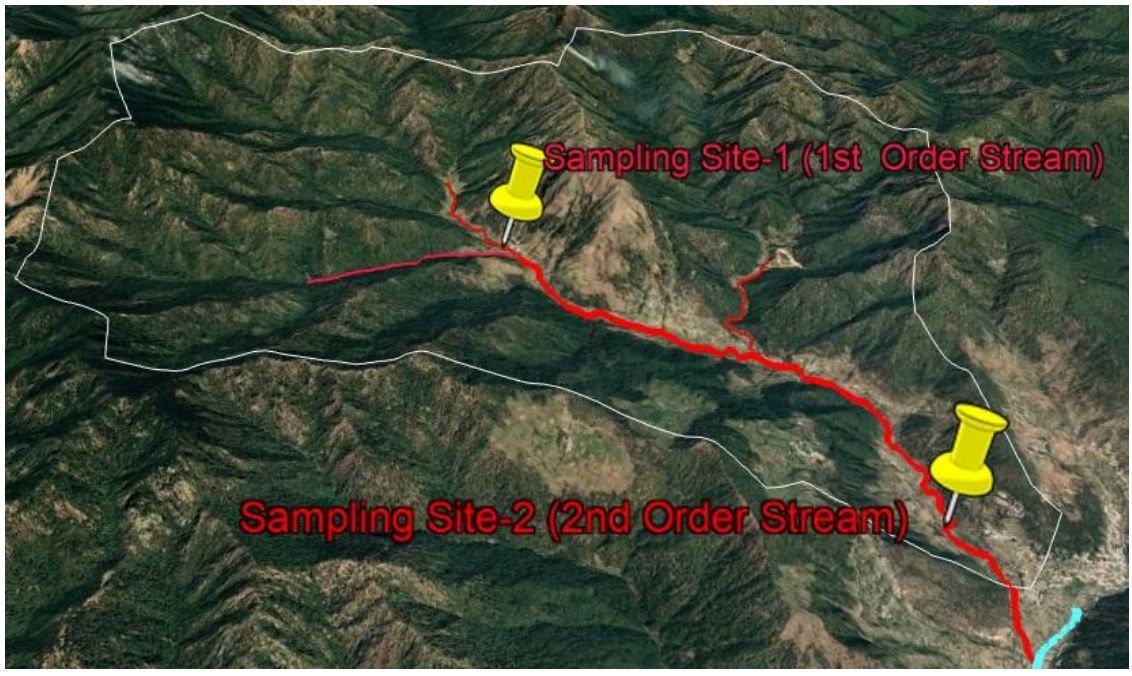

Fig. 1. Map showing the sampling sites (Image source: Google Earth)

The average physicochemical analysis of both the sites was done as per the standard method suggested by APHA [58].

Stones of different sizes were picked up from the bottom of the stream and a known area ($1cm^2$) was marked on the stone. The periphyton from the marked area ($1cm^2$) was scrapped with the help of a scalpel and brushes and mixed with a small amount of distilled water. Periphyton samples were preserved in 5% formalin solution.

In the laboratory, the periphyton were further concentrated in 100ml. The counting was done with the help of Sedgwick- Rafter counting slide using following formula:

$$n = (a \times 1000) \times b$$

Where:

n = number of units of Periphyton / cm^2.
a = average number of periphyton in a cubic millimeter capacity.
b = Concentration prepared in ml.

Photo micrographic images of phytoplankton were analyzed with the help of Stereo Zoom Trinocular Microscope with Tucsan camera attachment. The identification of the periphyton sample was carried with the help of stranded keys [59-62].

3. RESULTS

The average month-wise variations in the density of periphyton from Mal Gad stream is represented in Table 1. The overall mean density value of the periphyton was calculated to be highest number in January (198.20 ± 29.32 units cm^{-2}) whereas lowest in July (2.75 ± 0.25 Units cm^{-2}). The annual percentage composition of periphyton flora of Mal Gad showed the dominance of Bacillariophyceae (Diatoms algae) followed by Chlorophyceae (Green algae) and Myxophyceae (Blue-green algae).

Month-wise average ecological (Physico-chemical) parameters and variations in the density of periphyton of spring-fed Mal Gad are illustrated in Figs. 1 to 5. The lowest water temperature was noticed in January (12.1 ± 0.15°C) and highest in July (19.0 ± 0.25°C). Average water velocity frequently changed throughout the year with the minimum value in the month of January (0.18 ±0.05 ms^{-1}) while the highest value was obtained in July (0.42 ±0.05 ms^{-1}). Average minimum pH was observed in September (7.2 ± 0.50) and maximum in November (7.9 ± 0.75). Average dissolved oxygen was recorded highest in January (11.2± 0.25 mgl^{-1}) and lowest in October (8.7± 0.50mg l^{-1}). Average total Alkalinity was recorded minimum for the month of February (18.2± 1.10 mg l^{-1}) and maximum in November (30.4 ±13.25 mgl^{-1}).

Bacillariophyceae was obtained as the most important group from Mal Gad mountain stream which constituted the most foremost species group of phytoplankton. Bacillariophyceae was represented by 9 taxa. The diatoms were mostly characterized by the species of *Cymbella sp., Synedra sp., Navicula sp., Fragilaria sp., Gomphonema sp., Achnanthes sp., Bacillaria sp., Diatoma sp. and Tabellaria sp.* etc. *Cymbella sp., Navicula and Synedra sp.* were noticed to be the most dominant species amongst Bacillariophyceae.

Table 1. Monthly average variations of periphytic algae of the Mal Gad stream

Months	Diatoms	Green algae	Blue-green algae	Total numbers of periphyton units/cm²
May- 2020	66.97±5.2	50.63±2.20	4.95±0.50	22.55±13.15
Jun.,- 2020	62.75±7.4	40.12±5.23	4.63±0.55	07.50±09.17
Jul.,- 2020	nil	nil	nil	nil
Aug.,-2020	03.92±0.13	nil	nil	03.92±00.13
Sep.,-2020	35.78±3.85	10.27±1.38	2.06±0.38	48.11±05.43
Oct.,-2020	45.42±4.20	33.64±5.3	41.36±4.8	120.42±12.84
Nov.-2020	79.26±6.33	62.27±4.89	14.09±2.9	155.62±15.45
Dec.-2020	98.55±15.10	70.27±8.41	10.26±1.67	179.08±18.87
Jan.,-2021	113.59±14.75	72.84±11.23	11.77±2.10	198.20±19.07
Feb.,-2021	104.83±10.71	71.52±5.28	8.76±0.74	185.32±03.95
Mar.,-2021	96.81±9.05	51.92±3.27	4.05±0.75	152.78±03.59
Apr.,- 2020	76.27±2.05	61.59±6.29	3.29±0.91	141.15±10.31

Table 2. Check List of periphyton diversity from Mal Gad streams during May 2020 to April 2021

S. No	Periphyton	Name
A.	Bacillariophyceae	*1. Cymbella sp.* *2. Synedra sp.* *3. Navicula sp.* *4. Fragilaria sp* *5. Gomphonema sp.* *6. Achnanthes sp.* *7. Bacillaria sp.* *8. Diatoma sp.* *9. Tubelaria sp.*
B	Chlorophyceae	*1. Oedogonium sp.* *2. Spirogyra sp.* *3. Microspora sp.* *4. Volvox sp.* *5. Zygenema sp.* *6. Cladophora* *7. Geminela sp.* *8. Ulothrix sp.*
C.	Cyanophyceae	*1. Nostoc sp.* *2. Rivularia sp.*

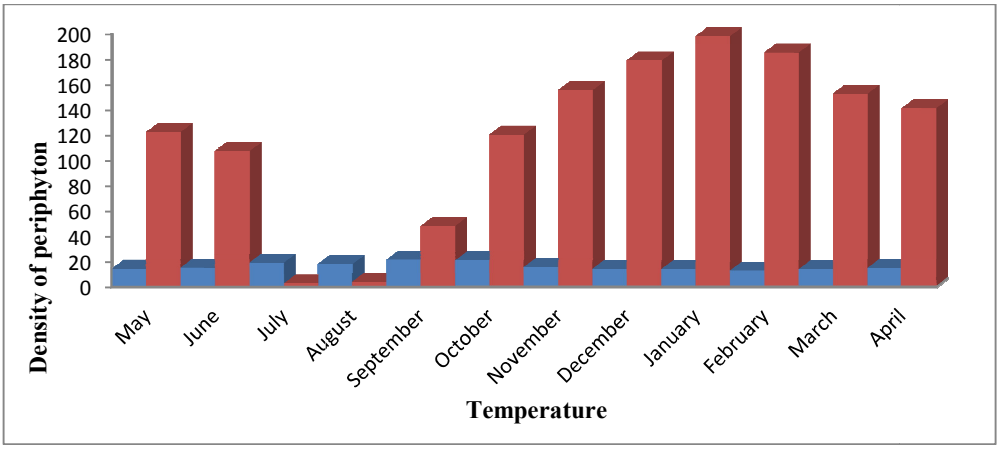

Fig. 2. Monthly variations in the average temperature and density of periphyton in Mal Gad stream

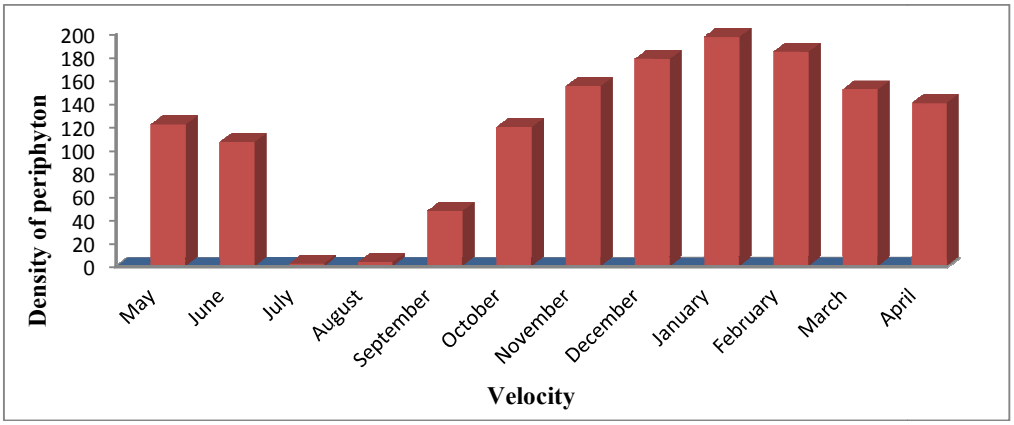

Fig. 3. Monthly variations in the average velocity and density of periphyton in Mal Gad stream

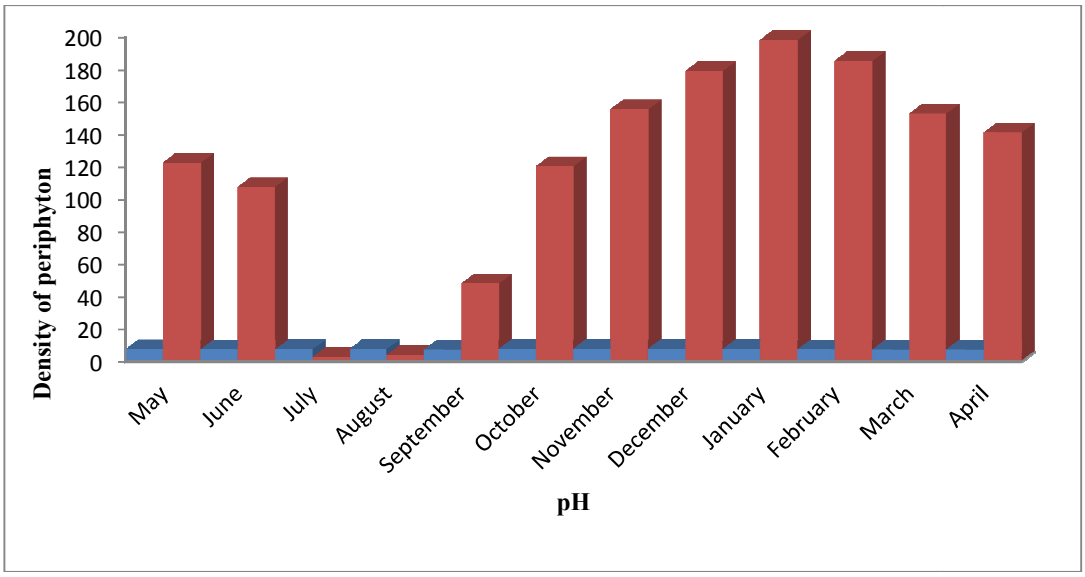

Fig. 4. Monthly variations in the average pH and density of periphyton in Mal Gad stream

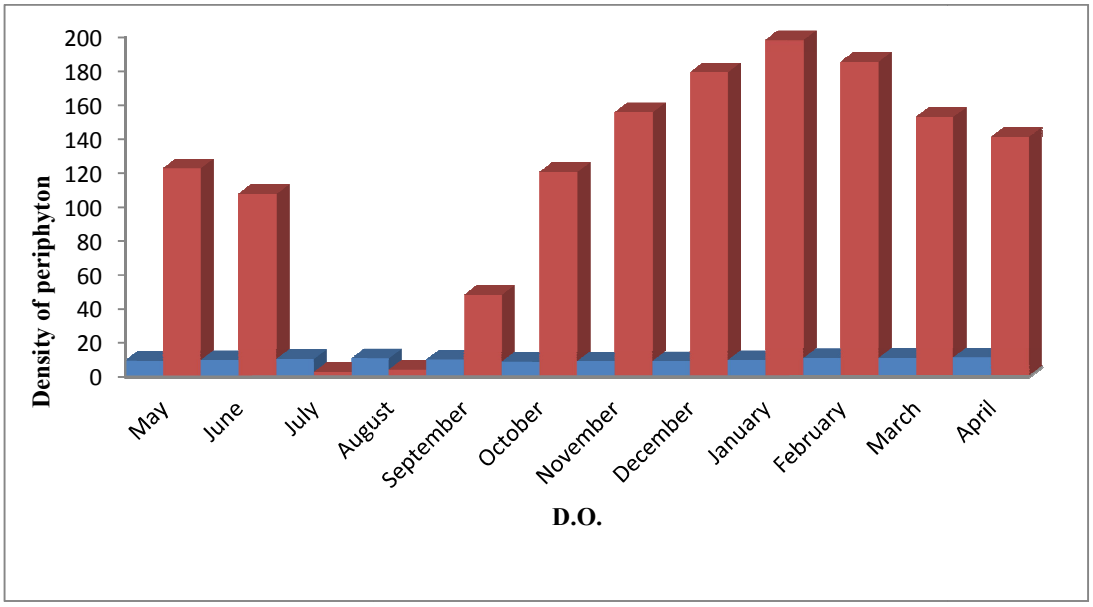

Fig. 5. Monthly variations in the average D.O. and density of periphyton in Mal Gad stream

Chlorophyceae was characterized by 8 taxa. Species of *Oedogonium sp., Spirogyra sp., Microspora sp., Volvox sp., Zygenema sp., Cladophora sp., Geminela sp., and Ulothrix sp*. *Oedogonium* sp., *Ulothrix sp*., *Spirogyra sp*. and *Cladophora sp.* were found as most dominant species at the sampling area.

Blue-green algae were also identified as the third and least dominant group represented by only 2 taxa. Species of *Nostoc* sp, and *Rivularia* sp. were noticed in good number.

4. DISCUSSION

In the present study, periphyton biomass and assemblage structure varied in different microhabitats. The study revealed that out of the two microhabitats of the stream, the riffle sustains higher periphyton biomass in comparison to the pools. This variations in algal biomass and assemblage composition between pool and riffle microhabitats could be due to the cumulative effects of various physicochemical factors like light, temperature, current, rainfall, turbidity,

substrate, depth, the chemical components of the stream water.

In the present work, we noticed that the periphytic biomass showed maximum value in the microhabitats having a flow velocity of 18.0cm/s. in January. A total of 19 genera were observed in the Mal Gad spring-fed hill-stream. The periphytic assemblage composition showed the predominant occurrence of Diatoms algae (Bacillariophyceae) followed by Green algae (Chlorophyceae) and Blue-green algae (Myxophyceae). Nineteen genera of which 09 belonged to Diatoms algae (Bacillariophyceae), 08 to Green algae (Chlorophyceae) and 02 to Blue-green algae (Myxophyceae). Sundar et al. [63], in their study at Gaula river located at the foothills of Kumaon Himalayas, noticed 48 Phytobenthic genera of which 30 belonged to Bacillariophyceae, 13 to Chlorophyceae and 5 to Cyanophyceae. According to Baluni [55], a total of 25 genera of periphyton belonging to Bacillariophyceae (11), Chlorophyceae (10) and Cyanophyceae (04) were obtained in Ragda Gad stream. Bhatt and Yousuf [64] worked on seven springs stream of Kashmir showed a total of 50 genera of periphyton community, of which 33 belonged to Bacillariophyceae, 9 to Chlorophyceae, 5 to Cyanophyceae, 2 to Chrysophyceae and 1 to Euglenophyceae.

The highest number of periphyton was noticed during the December and January months in the Mal Gad stream, which may be due to the increased growth efficiency of periphyton during this period in response to favorable physicochemical attributes.

Turbidity owing to the suspended particles has a blanketing bottom effect that interferes with the photosynthetic activity by reducing the light penetration [65,66]. Quinn et al. [67] observed that periphytic productivity decreases with increasing shade and suggested that energy is derived from upstream sources. Nikora et al. [68] noticed largest influence of stream velocity in periphytic mat selectivity and concluded that the mechanism of the periphyton turbulence interaction is connected to a certain degree with viscous effects. There are reports that benthic algal communities grow faster and can accumulate more mass unless the force of moving water is too great and algae are sheared from the substratum [69,70].

Availability and nature of Periphyton and physicochemical parameters in the stream has a direct impact on the length-weight relation and relative condition factors [71-81], aging biology [82-85], breeding biology [86-91], feeding [21], distribution and functioning of the fish [92-96]. An aquatic mites [38-45] and macrozoobenthos [46-56] density and diversity have been depending on the good feeding ground. The periphyton density is in turn affected by the stream ecological conditions which are hugely influenced by the anthropogenic intervention in the immediate catchment as a whole.

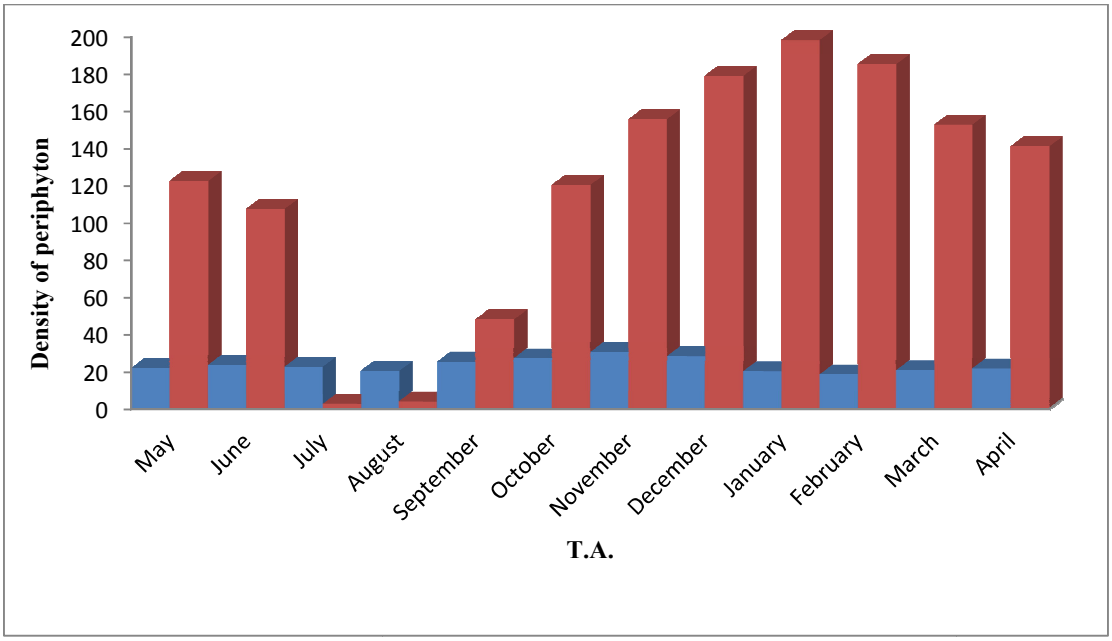

Fig. 6. Monthly variations in the average T.A. and density of periphyton in Mal Gad stream

5. CONCLUSION

The hill streams of the Himalayan region are geologically and ecologically sensitive. The knowledge regarding the composition and distribution of the aquatic community will help in the sustainable management of related resources. The present observations showed that the mountain stream is having crystal clear water, and is free from pollution as Bacillariophyceae and Chlorophyceae are better represented. Further as a result of less anthropogenic pressure, the quality of water is fairly good.

The present investigation will be helpful in enhancing the knowledge about the natural diet of fishes and the production potential of the water body. Based on the study the stream is favorable for the culture of snow trout fish on a commercial scale.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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