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**IMPACT OF TEMPERATURE AND DISSOLVED OXYGEN ON THE  
MACROINVERTEBRATE DENSITY OF A HILL STREAM IN  
WESTERN HIMALAYA**

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**ABSTRACT**

The present study was conducted in a perennial stream in the Barog Hills (District Solan), Himachal Pradesh to study the variations in the monthly macroinvertebrate density in accordance to temperature and dissolved oxygen. Water temperature and dissolved oxygen were found to be negatively correlated ( $r = -0.83$ ,  $p < 0.01$ ). Negative correlation was observed between macroinvertebrate density and temperature at Barog ( $r = -0.07$ ). Decrease in dissolved oxygen and increase in temperature indicates stressful conditions for the macroinvertebrates to survive. Pollution should be checked as these macroinvertebrates act as bioindicators and food for higher trophic levels such as fishes.

**Keywords: Macroinvertebrate density and temperature, Barog Hills (District Solan), Himachal Pradesh**

**INTRODUCTION**

Dissolved oxygen (DO) is one of the most important parameters in water quality assessment as it reflects the physical and biological processes prevailing in the water (Trivedi and Goel, 1986). Temperature affects dissolved oxygen concentration as it is negatively correlated with dissolved

oxygen. DO is an important parameter for the survival of benthic macroinvertebrates which act as bioindicators. The present study was hence carried out to study the impact of temperature and dissolved oxygen on the macroinvertebrate density of a hill stream in western Himalaya

## MATERIALS AND METHODS

### *Study Area*

The study area of the present work lies in Himachal Pradesh located in the northwest Himalayan region (between 30°23' - 33°12' N lat., 75°37' - 79°04' E. long). The area is drained by an intricate network of springs, streams and rivers crisscrossing the entire region. A spring fed perennial stream in the Barog Hills (District Solan) was selected for the present study. It flows southeastwards to discharge in the Raboun tributary of the Giri-Yamuna drainage. The area has four distinct seasons: spring (late February to April), summer (May to August), autumn (September to middle November) and winter (middle of November to middle of February). A distinct wet summer period during the southwest monsoon months of July-August is distinguished from summer in May-June. The study area is a small riffle close to the source of the stream near Barog railway station (7km from Solan; altitude 1500m above sea msl. (30°55' N Lat; 77°06' E long.). The stream flows through a narrow valley, largely exposed to sunlight. Its substrate comprises largely of gravel-rubble/ loose stone substratum.

### *Macroinvertebrate sampling and physicochemical parameters*

The benthic macroinvertebrates were sampled monthly by quantitative and

qualitative methods from August 2014- July 2016. Quantitative samples were taken with a Surber's sampler (25 cm<sup>2</sup> area; mesh opening- 0.4mm). The Surber's sampler was operated by using the method given by Welch (1948). To minimize error, five replicates of macroinvertebrates and water samples were taken on each occasion. Benthoses were identified by upto genera by using various keys. The water surface temperature was measured using a standard mercury Celsius thermometer. Dissolved oxygen by Winkler's Azide titrimetric method.

## RESULTS

Variations in mean values of water temperature recorded at Barog, sampling site is shown in Figure 1. Annual mean temperature at Barog was 14°C ±1.24 and 13.08°C ±1.24 in 2014-15 and 2015-16 respectively. Monthly fluctuations in water temperature followed more or less similar trend during both the years. During the first year, maximum temperature of 20°C was recorded in July 2015 and minimum of 7°C was observed in December 2014 and January 2015. In the second year, maximum temperature of 20°C was found in July 2016 and minimum of 7°C in January 2015. Temperature followed a regular trend of decrement from August to January and increased from February to reach a peak in July.

Mean dissolved oxygen values of 4.2 mg/l  $\pm$ 0.46 and 4.15 mg/l  $\pm$ 0.46 were recorded during first and second year respectively at Barog. During first year of study, dissolved oxygen concentrations decreased from August to October and increased from November to reach a maximum in January with a sudden drop in December (Figure 2). It then decreased from February to July with a slight increase in the month of April. In the second year of study, dissolved oxygen decreased slightly from August to

September. It then increased from October to December, decreased from January to July with a slight increase in the month of May. Maximum values of 6.66 mg/l and 6.24 mg/l and minimum values of 1.86 mg/l and 1.66 mg/l were recorded for first and second year respectively.

Variations in macroinvertebrate density are shown in Table 1. Minimum density was noted in monsoon months and maximum in premonsoon and post monsoon months.

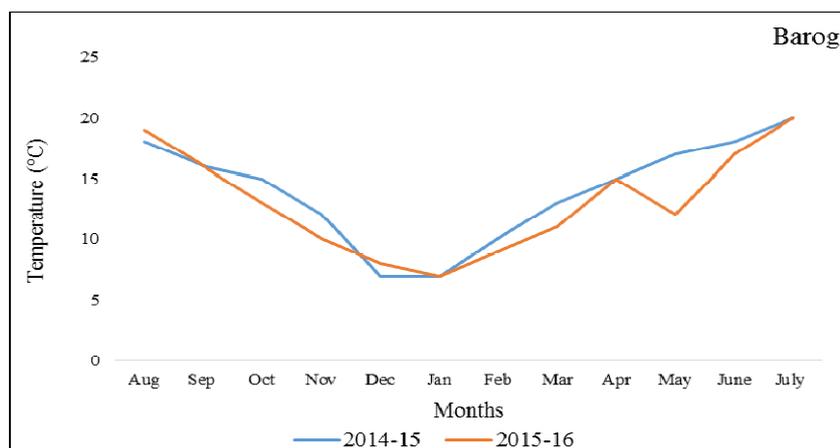


Figure 1: Monthly surface temperature fluctuations in a perennial hill stream at Barog near Solan, Himachal Pradesh during the study period 2014-2016

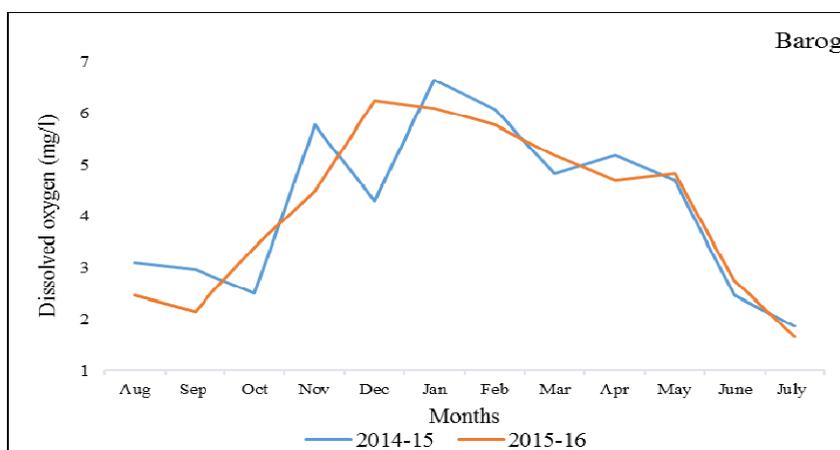


Figure 2: Monthly fluctuations in dissolved oxygen in a perennial hill stream at Barog near Solan, Himachal Pradesh during the study period 2014-2016

Table 1: Relative density of macroinvertebrate groups at Barog during two years of study (2014-2016)

	Relative density
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Months	2014-15	2015-16
Aug	0.08	0.14
Sep	0.91	9.85
Oct	6.07	15.5
Nov	6.66	11.74
Dec	14.16	16.65
Jan	7.62	5.92
Feb	3.65	13.94
Mar	0.34	10.42
Apr	16.97	8.16
May	29.21	1.49
June	7.15	1.66
July	7.17	4.53

## DISCUSSION

Water temperatures in the stream varied in accordance with seasons and atmospheric temperatures at all sampling sites. During summer season, solar radiation and clear sky conditions enhanced the atmospheric temperature leading to rise in water temperature of the stream (Sharma, 2012). Water temperature was negatively correlated with dissolved oxygen at Barog ( $r = -0.83$ ,  $p < 0.01$ ). A negative correlation between temperature and dissolved oxygen was also observed by Raina *et al.* (1984), Pathani (1995) and Ishaq and Khan (2013). Rise in temperature increased metabolic activities of biota leading to higher consumption of dissolved oxygen by organisms, and also oxygen holding capacity of water gets decreased (Uehlinger *et al.*, 2000). Negative correlation was observed between macroinvertebrate density and temperature at Barog ( $r = -0.07$ ). Sharma *et al.* (2009), Ishaq and Khan (2013) and Negi and Mamgain (2013) also found that

macroinvertebrate density decreased with the increase in water temperature.

Comparatively low dissolved oxygen values in monsoon months indicated increase in organic pollution due to anthropogenic activities. Input of organic materials created conditions for growth of large population of bacteria, which consumed large amounts of DO and decreased the overall level of oxygen. Another possibility was the addition of inorganic fertilizers along with the runoff water from surrounding agricultural fields, thus increasing the level of nitrates and phosphates, which supported dense growth of algae and aquatic plants in the stream. Low levels of DO at night due to removal of oxygen by algae and submerged plants for respiration created stressful conditions for some macroinvertebrates (Connolly *et al.*, 2004).

## CONCLUSION

Decrease in dissolved oxygen and increase in temperature indicates stressful conditions for the macroinvertebrates to survive. Pollution should be checked as these

macroinvertebrates act as bioindicators and food for higher trophic levels such as fishes.

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