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Seasonal Variation in the Macrobenthic Invertebrate Densities of Aripal and Watalara Streams of Kashmir Himalaya, India

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Abstract

The present study reflects the seasonal variation of macrobenthic invertebrates from Aripal and Watalara streams in Kashmir Himalaya. During the study, a significant difference ($p<0.05$) was observed in the density of Annelida, Mollusca, and Arthropoda on a seasonal scale. Macrobenthic invertebrates were found to be at their highest density during summer and autumn, whereas they were recorded lowest during winter and spring. The total density during summer and autumn was found to be significantly different ($p<0.05$) when compared to winter and spring seasons. The data also depicted the maximum density of Arthropoda followed by Mollusca and Annelida. The study reveals the seasonal stability of the stream ecosystem within the temperate region and also provides the baseline information for macrobenthic invertebrate community structure.

Keywords: Annelida, Arthropoda, Benthic Macroinvertebrates, Mollusca, Density, Season, Streams

1. Introduction

Macrobenthic invertebrates are diverse in their distribution and composition as they inhabit the different aquatic habitats and represent mostly three invertebrate phyla *viz.*, Annelida, Mollusca, and Arthropoda in which the latter two form the largest phyla of Animal Kingdom[1,2]. The Kashmir Himalaya represents a temperate region with spring, summer, autumn, and winter season. Seasonal dynamics have a significant impact on the emergence, growth, development, and reproduction of macrobenthic invertebrates inhabiting the streams. The lotic waters like streams and rivers are susceptible to various environmental alterations in hydrological, geomorphological, and biological parameters[3–5]. In the temperate regions, streams and rivers are influenced by climatic conditions and habitat characteristics which ultimately have an impact on the macrobenthic invertebrates and fishes[6,7]. Macrobenthic invertebrates have high variety of structural and behavioral adaptations which provide them the advantage over different trophic resources in the aquatic ecosystem[8,9]. Macrobenthic invertebrates form an important group as far as their role in energy flow, stability, biomonitoring of water quality and nutrient cycling in the ecosystem is concerned. These organisms are an important source of food to fishes and play an important role in the regulation of primary production, breakdown of detritus, and downstream nutrient spiraling in the lotic water system[10]. Various studies have been carried out on the distribution, richness, abundance, and diversity of macrobenthic invertebrates in the streams and rivers[11–13]. While the seasonal variation plays a key role in the dynamics of macrobenthic invertebrates but little attention has been given to the seasonal variation in the macrobenthic invertebrates from Kashmir Himalayan streams. The purpose of the present work is to study the seasonal variation in the density of

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macrobenthic invertebrates in order to determine the stability of the stream ecosystem within the temperate region and to provide the baseline information for community structure.

2. Materials and Methods

2.1 Study Area

The study has been carried out seasonally from Aripal and Watalara streams located in the Tral subdivision between geographic coordinates 33.93°N and 75.10°E with an altitude of 1662 m a.s.l., in the district Pulwama of Kashmir valley, India[14]. These streams form the two right bank tributaries of River Jhelum in the district. During the survey, sites were selected on the basis of habitat heterogeneity, type of bottom substrate, and water quality. Three sites were selected from each stream *viz.,* Site A1 (34.01˚N and 75.04˚E), Site A2 (33.55˚N and 75.05˚E), and Site A3 (33.53˚N and 75.02˚E) in the Aripal stream while Site W1 (33.57˚N and 75.09˚E), Site W2 (33.54˚N and 75.07˚E), and Site W3 (33.53˚N and 75.04˚E) in the Watalara stream. The geographical representation of sampling sites is presented in Figure 1 while the habitat characteristics during different seasons are depicted in Figure 2.

2.2 Field and Laboratory Methods

The macrobenthic invertebrate samples were collected as three replicates from different habitats within sampling reaches of streams by using a standard Surber net (EU-WFD implemented) with an area of 0.9 m^2 and mesh size of 0.5 mm[15]. The collected macrobenthic invertebrate samples were preserved in 70% alcohol and identified under dissecting stereo zoom microscope (Magnus MS 24) and counted with the visual sort method[16,17]. The density was calculated as the number of individuals (ind.) per square metre with the given formula:

Density (Number of individuals/m^2) = N/A×S

where, N = Number of individuals actually counted in the sampler

A = Area of the sampler; S = Number of samples taken

2.3 Data Analysis

During statistical analysis, the monthly data of macrobenthic invertebrate phyla was clubbed from June 2018 to May 2020 and was arranged into four seasons *viz.,* summer, autumn, winter, and spring. The density of different macrobenthic invertebrate phyla was calculated in MS Excel 2016 and the seasonal data of different phyla was subjected to one-way ANOVA followed by Duncan's multiple range test using software SPSS (version, 20).

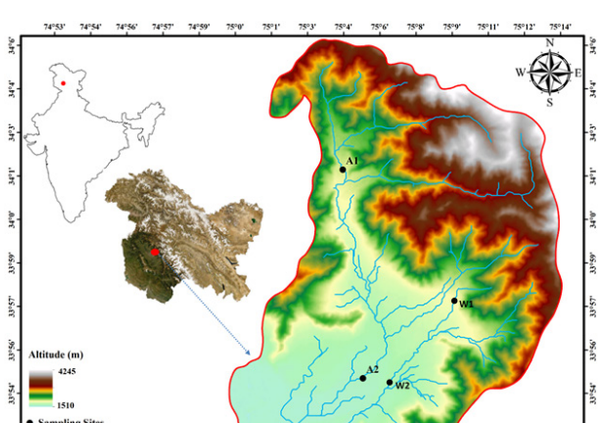


Figure 1. Geographical representation of sampling sites of Aripal and Watalara streams.

A1-Aripal A2-Chandrigam A3-Kadelbal W1-Lalpora W2-Saimoh W3-Chursoo

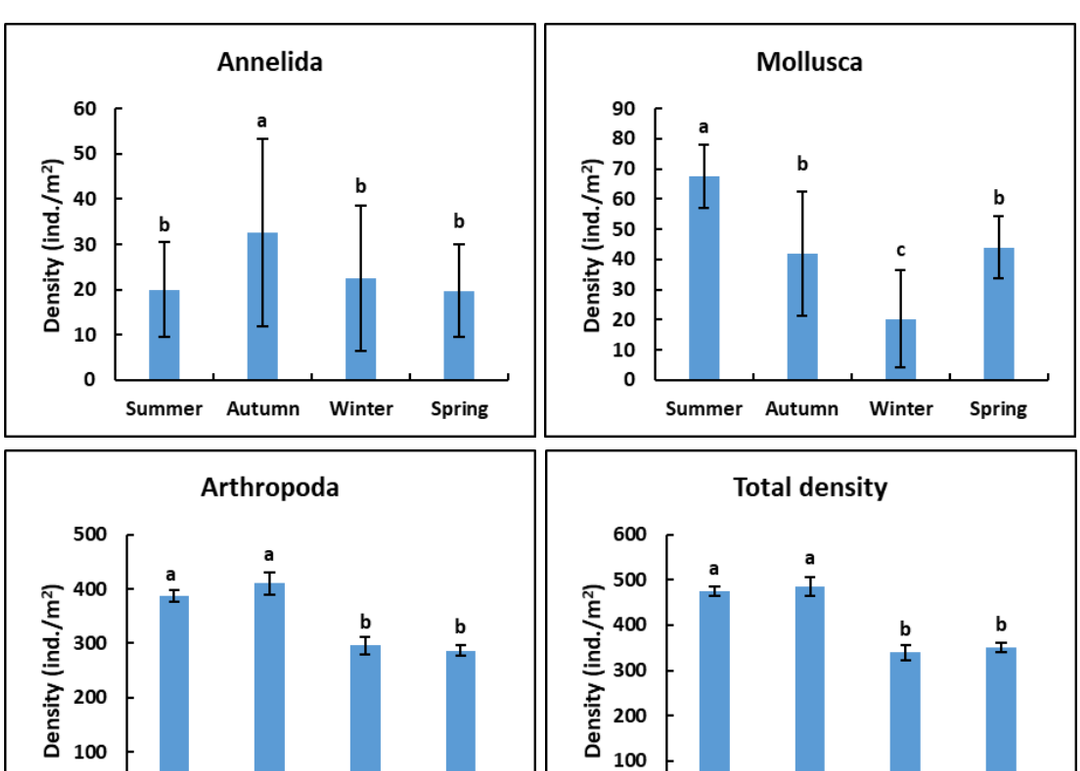
3. Results

The seasonal variation in the density of macrobenthic invertebrates in Aripal and Watalara streams is presented in Figures 3 and 4.

The seasonal variation in the density of different phyla of macrobenthic invertebrates in Aripal stream is presented in Figure 3, wherein it is revealed that the density of Annelida was found to be minimum (19.8±10.3 ind./m^2) during spring while maximum (32.6±20.7 ind./m^2) during autumn season. The density of Mollusca was found to be minimum (20.3±16.4 ind./m^2) during winter while maximum (67.7±37.9 ind./m^2) during summer season. The density of Arthropoda was found to be minimum (286.5±117 ind./m^2) during spring while maximum (410.4±112.4 ind./m^2) during autumn season. The total density of macrobenthic invertebrates was found to be minimum (339.1±115.8 ind./m^2) during winter while maximum (484.9±111.3 ind./m^2) during autumn season.

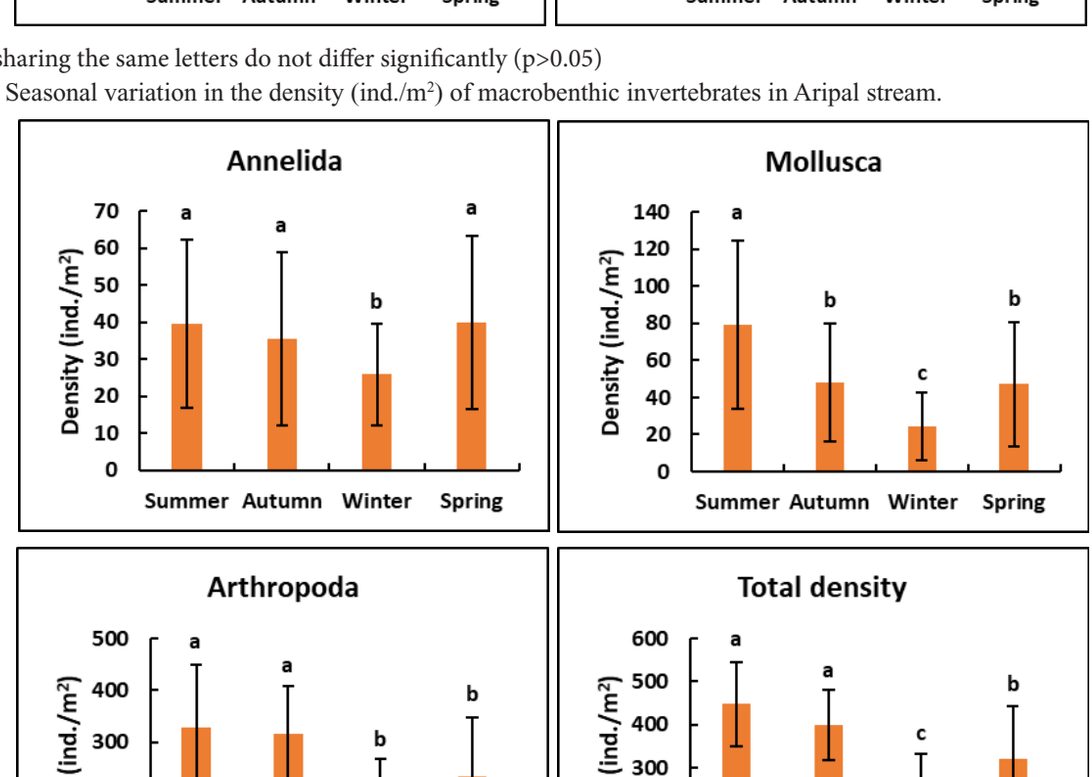
The seasonal variation in the density of different phyla of macrobenthic invertebrates in Watalara stream is presented in Figure 4, wherein it is revealed that the density of Annelida was found to be minimum (25.9±13.7 ind./m^2) during winter while maximum (40±23.4 ind./m^2) during spring season. The density of Mollusca was found to be minimum (24.3±18.1 ind./m^2) during winter while maximum (79.3±45.6 ind./m^2) during summer season. The density of Arthropoda was found to be minimum (197.7±70.8 ind./m^2) during winter while maximum (328.8±120.1 ind./m^2) during summer season. The total density of macrobenthic invertebrates was found to be

Figure 2. Photographs of the study area during different seasons of a year depicting habitat characteristics. Aripal stream (Pictures A,C,E,G); Watalara stream (Pictures B,D,F,H) A-B: summer (riparian vegetation), C-D: autumn (organic matter), E-F: winter (no vegetation), G-H: spring (high flow)



Seasons sharing the same letters do not differ significantly ($p>0.05$)

Figure 3. Seasonal variation in the density (ind./m^2) of macrobenthic invertebrates in Aripal stream.



Seasons sharing the same letters do not differ significantly ($p>0.05$)

Figure 4. Seasonal variation in the density (ind./m^2) of macrobenthic invertebrates in Watalara stream.

minimum (247.9±85.2 ind./m^2) during winter while maximum (447.8±97.2 ind./m^2) during summer season.

The total density of macrobenthic invertebrates from both streams revealed a significant variation ($p<0.05$) in relation to the summer and autumn seasons when compared to winter and spring seasons.

4. Discussion

A season represents the climatic conditions in the region over a period of time. Based on the annual climatic conditions, the temperate regions have four seasons *viz.,* spring, summer, autumn, and winter while the tropical regions have generally two seasons *viz.,* monsoon and dry season. Seasonal variation in the climatic conditions cause changes in water discharge and temperature of water bodies throughout the year[18] which have a significant impact on the life cycle of macrobenthic invertebrates and the variation of species[19]. The seasonal changes in the Kashmir Himalaya are usually influenced by South-Western monsoons starting from late summer[20]. The present study describes the density of macrobenthic invertebrates in Aripal and Watalara streams of Kashmir Himalaya. The findings in our study revealed a significant difference in the density of major phyla of macrobenthic invertebrates during the different seasons. The overall maximum density of macrobenthic invertebrates was observed in the summer and autumn season while minimum in the winter and spring season. The difference may be due to the dynamics in the life cycle of macrobenthic invertebrates, physico-chemical parameters and habitat characteristics of the streams. The maximum emergence of macrobenthic invertebrates during the summer and autumn seasons indicates the favorable habitat conditions for their colonization and establishment in the streams. The seasonal variation in the temperature and organic matter is responsible for maximum emergence of macrobenthic invertebrates in the streams and rivers[21–23]. The data also depicted the maximum density of Arthropoda contributing to macrobenthic invertebrates followed by Mollusca and Annelida. The reason behind the maximum density of Arthropoda may be due to the major contribution of aquatic insects and their preferences to the stony bottomed streams and rivers. The overall variations in the climatic conditions and habitat may cause changes in the density and biomass of macrobenthic invertebrates which in turn have significant effects upon the higher tropic level in the aquatic food chain such as fishes and aquatic birds. The study on seasonal variation provides information regarding the importance of the stability of stream ecosystem and dynamics in the quantitative and qualitative community structure of macrobenthic invertebrates.

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6. Statements

6.1 Author Contribution

All the authors have contributed to this study.

6.2 Data Availability Statement

The data that supports the findings of this study are available from the corresponding author upon reasonable request.

6.3 Conflict of Interest

The authors declare no conflict of interest.

7. References

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