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Original Article

Altitude and Habitat Influence on Species Composition: A Multivariate Approach

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Abstract

Considering the patterns of species composition and the factors influencing them which includes different type of environmental variables are very much crucial for determination of the community composition and biodiversity. In this study, we have designed and analyzed pollinating hoverfly (Insecta: Diptera: Syrphidae) species assemblages across five sampling stations using Bray–Curtis dissimilarity, hierarchical clustering, and two-dimensional Multidimensional Scaling (MDS) ordination. Here the MDS ordination analysis actually indicates towards the effect of altitude as an environmental driving force whereas by analyzing the data generated from dissimilarity heatmap and hierarchical clustering, it denotes that species diversity varies among the station to certain extent while station 5 representing the higher diversity. Altogether, these analyses validate that both spatial variation and environmental gradients help to shape the species assemblages of any community. Moreover, this study further highlights the utility of using different dissimilarity metrics, clustering, and ordination to better analyse beta diversity and the ecological factors driving community differentiation in heterogeneous habitats.

Keywords: *Bray–Curtis Dissimilarity; Beta Diversity; Community Structure; Environmental Gradients; Multidimensional Scaling (MDS); Species Composition*

Introduction

In the area of ecology and biodiversity research, understanding the pattern and key environmental drivers for different species composition across a more or less similar patch of ecosystem is crucial (Hill, 1973; Jost, 2006). The distribution of species in a particular ecosystem is getting affected by several factors which includes both environmental as well as anthropogenic (Cassini, 2011; Külköylüoğlu, 2017). All of these factors together determine how the distributional pattern of the species will be taken place in a particular environmental patch. The determination of these factors helps to have a better understanding into ecological processes such as species turn over, niche partitioning and mechanism for community assemblage etc (Hill, 1973; Noweg, 2024). Measuring beta diversity for any particular ecosystem is thus of immense importance (Chwala, 1996; Schütte & Schrimpf, 2002).The present study has included a multivariate analysis approach to understand the relationships among different ecological sites (Dormann, 2012; Gerbing, 2024, Hill, 1973; Hill, 1987; Külköylüoğlu, 2017). Thus by combining different analysis approaches to trace out the the key driver of species diversity (Jost, 2006; Cassini, 2011; Noweg, 2024).

Different environmental factors specifically the altitude play a crucial role in higher elevation ecosystem. Based upon elevation gradient and associated environmental hardships, species diversity may increase or decrease based upon their particular resilience ability (Noweg, 2024; Yang, 2025). Distribution of a

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species along an elevational gradient is further affected by several sub factors like temperature, rain fall, soil pattern, humidity, availability of resources etc. (Jun, 2011; Külköylüoğlu, 2017). Therefore the present work has dealt with this point to represent how slight variation in altitude leads to a bigger difference in species composition even across a relatively small landscape (Cassini, 2011; Hill, 1973).

In the current study, we have analysed the species diversity along the five selected study sites. By integrating all of the three approaches together, a detailed understanding of species variability has been represented. The outcome is expected to contribute to the need of integration of multivariate analysis in understanding species diversity better.

Materials and Methods

This particular study has been conducted prioritising five distinct stations of a grassy medow habitat from the mid hill zone of Himachal Pradesh. These stations are further denoted as S1, S2, S3,S4 and S5. The sampling stations has been marked with utmost attention for data collection, interpretation and analysis. Here the main key factor of selection was habitat heterogeneity. Data in the form of hoverfly species diversity has been collected using standard collection and preservation method for insects. Interpretations included the presence and counts of individual species within defined sampling units, and all data were georeferenced to enable spatial analyses. The statistical analysis in this particular study has been performed using R (R Core Team, 2016) and Python (Python Software Foundation, 2023), employing packages tailored for ecological data analysis.

Results

The data derived has been analyzed using the above mentioned statistical software and a result comparing the species abundance and richness across various habitat has been generated. The overall finding suggests that station 3 has highest species abundance with 67.69% whereas it is significantly lower for other stations. On the other hand, Station 1 showed the highest species richness with 16 unique species; Stations 3, 2, 5, and 4 had 14, 11, 11, and 7 species respectively whereas the single habitat h3 showed a species richness of 34 unique species. So overall confirming Station 3's highest abundance and Station 1's highest species richness. In this article, analysis focused on comparing species compositions among stations to examine beta diversity, which reflects species turnover and community differentiation.

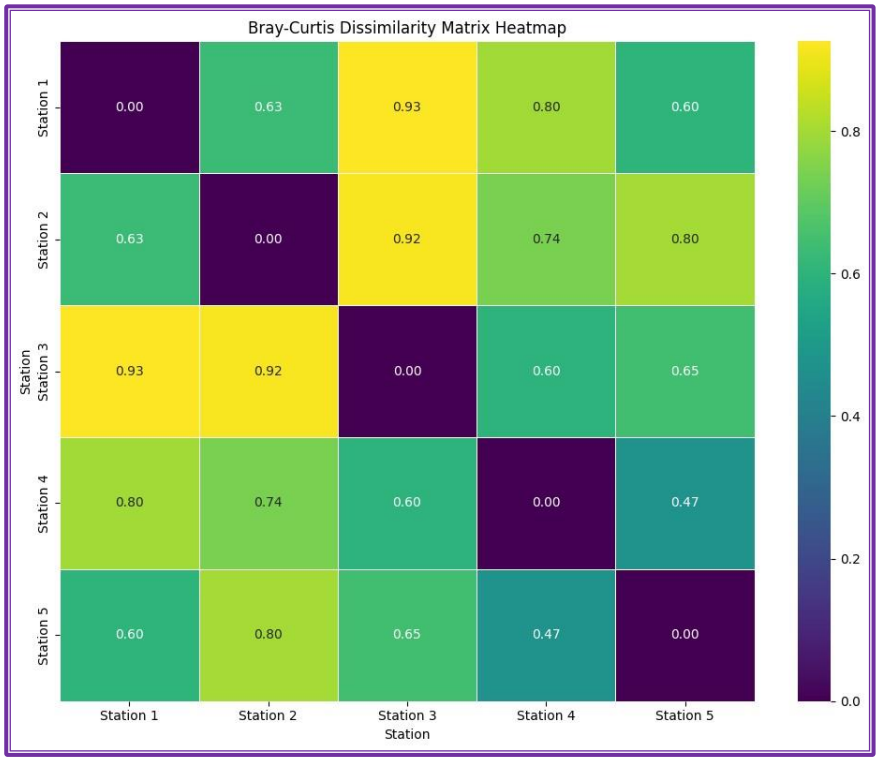

Figure 1: *Heat Map of the Bray-Curtis Dissimilarity Matrix*

In this figure 1 Heat map showing pairwise Bray–Curtis dissimilarity values among five sampling stations, illustrating differences in species composition between each pair. The Bray–Curtis dissimilarity ranges from 0 (identical species composition) to 1 (completely different composition). Here in the figure, each cell represents the how the different stations varies differently within the habitat. The darker shades here represent lesser diversity and more similarity while the lighter shade represents the reverse phenomenon. According to this figure 1, station 1 and station 3 is highly diverse (value =0.93) whereas station 4, 5 has lesser diversity (value=0.47).

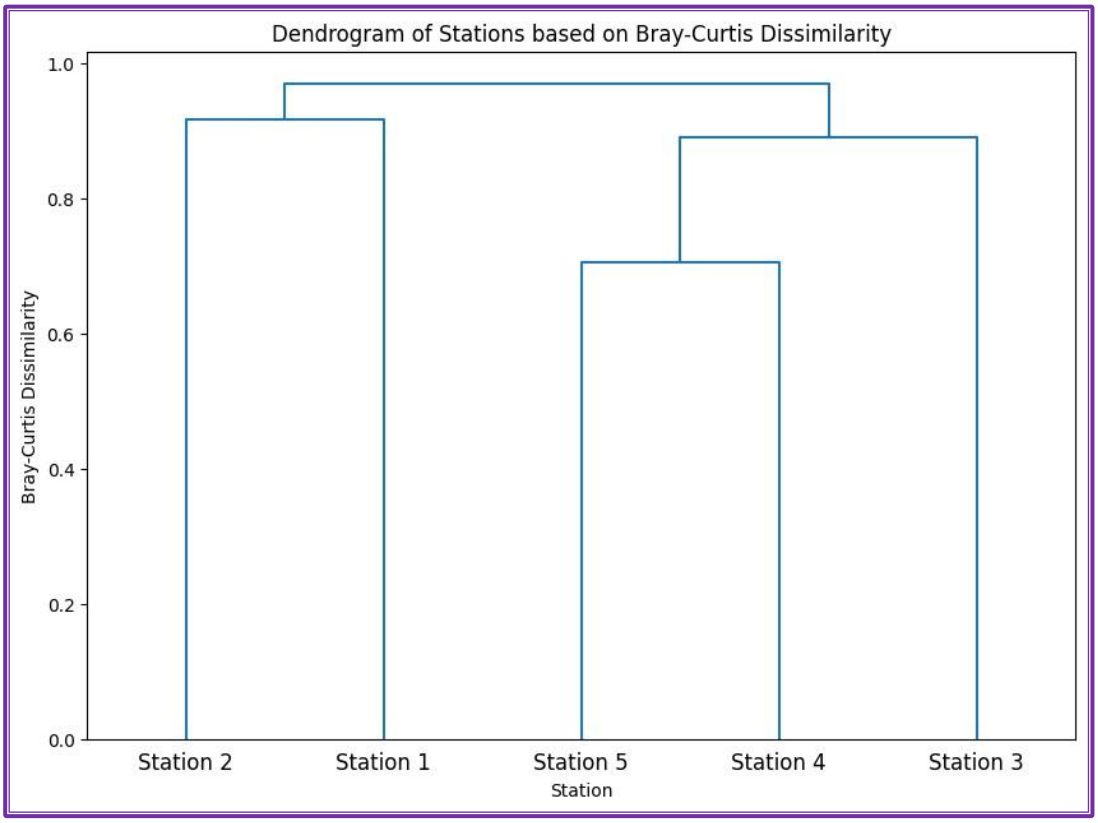

Figure 2: *Dendrogram*

Figure 2 represents the clustering of five selected sampling stations based upon the data generated from Bray-Curtis dissimilarity values ranging from 90 to 1. Here the lowering of value indicates greater diversity in the species assemblage whereas higher value represents the reverse phenomenon. According to figure 2, station 4 and station 5 cluster together and represents a lower dissimilarity value on the other hand another cluster has been formed by station 1 and station 2. Whereas station 3 has formed a completely separate branch by representing more unique and diverse species composition. Overall, it can be said based upon the dendogram analysis that station 1, 2 and station 4,5 have similar species community whereas different for station 3.

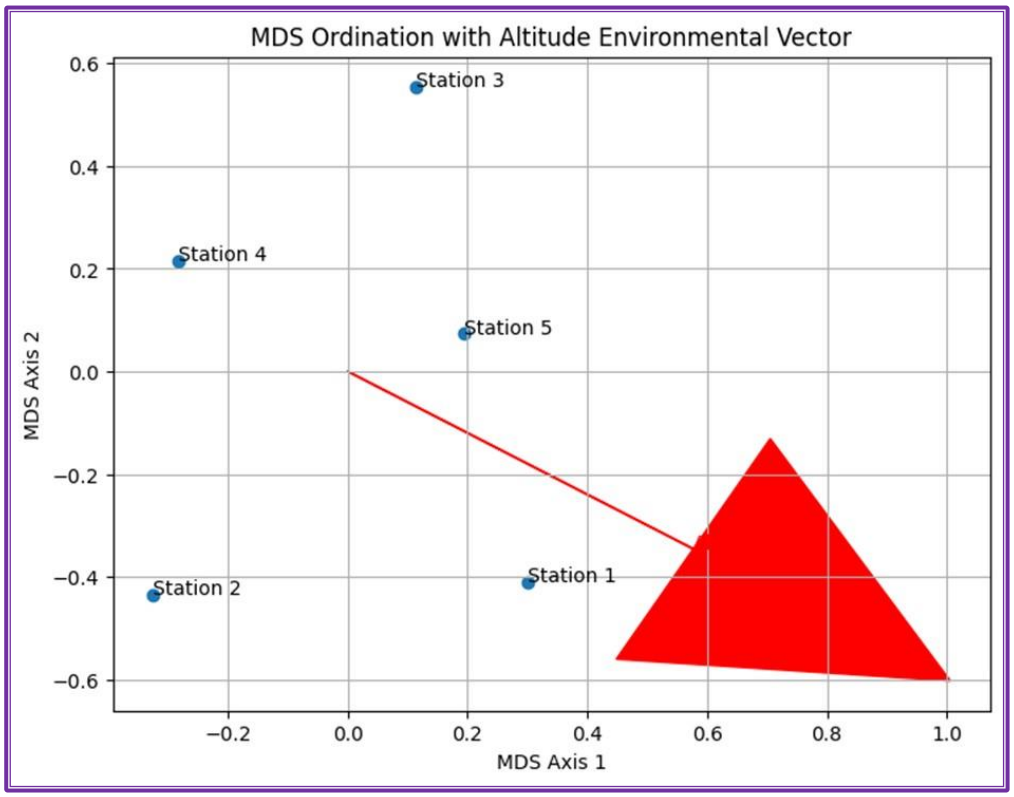

Figure 3: *Two-dimensional Multidimensional Scaling (MDS) Ordination Diagram*

The figure 3 represents the result of MDS (two dimensional non metric multidimensional scaling) which represents the ecological distances among the five sampling stations. In the figure the blue point actually represent the relative position of all the sampling stations in reduced ecological space. The red arrow here represents the environmental fitting factor for the altitude. Stations located near the arrow's direction are more strongly affected by altitudinal fluctuations than those stations which are located away. Overall this data analysis represents how the altitude is affecting the diversity and distribution of species across variable altitudinal gradient.

Discussion

The graphical illustration represented based upon figure 1, 2 and figure 3, the species diversity has been matched across the selected five sampled station of the study area. The figure 1 that represents the Bray-Curtis dissimilarity heat map is actually showing significant variations within the stations. According to the analysis, Station 1 and station 3 had very different species composition whereas it also denotes station 4 and station 5 had more or less similar species arrangement thereby representing a diverse range of species assemblage across the selected stations. On the other side, in figure 2 which is a dendrogram, it represents the grouping of the stations based upon their species diversity and similarity. Which further denotes that station 4 and station 5 shared similar species composition thus grouped together whereas same for station 1 and 2 forming another group together while station 3 emerges as a separate group because of its distinct level of diversity in species composition. Lastly figure 3 that is the MDS ordination provides a multi-disciplinary perspective by representing the ecological distances of the stations in a reduced space. Stations placed close together in the MDS actually represent consistency as represented earlier by the patterns represented in figure 1 and figure 2. Moreover they has been found to be influenced by altitude in a large proportion which further contribute to the face that station 3 has been placed in a distant due to its variation in species assemblage due to differential environmental composition. Overall, these analyses together demonstrate that both spatial proximity and environmental factors like altitude influence the species composition across different habitats to a great extent. The analysis and their similar representation have further strengthened this outcome.

Conclusion

The overall combined analysis of all this three statistical parameter reflects the nature of species diversity and abundance across the selected stations as well as how the environmental factor is affecting it. It reflects that station 4 and station 5 have similar species composition because of their similarity in shared niche as well as environmental factors. Station 1, 2 show less similarity but not that much uniqueness to be considered as distinct whereas station 3 exhibits remarkably distinct diversity. This study was overall a small approach to indicated the necessity of integrating multiple multivariate approaches to understand species diversity across different habitats of any important ecosystem.

Conflict of Interest

The authors declare that they have no competing interests.

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References

Cassini, M. H. (2011). Ecological principles of species distribution models: the habitat matching rule. *Journal of Biogeography*, *38*(11), 2057-2065. https://doi.org/10.1111/j.1365-2699.2011.02552.x

Chwala, E., & Waringer, J. (1996). Association patterns and habitat selection of dragonflies (Insecta: Odonata) at different types of Danubian backwaters at Vienna, Austria. *Archiv für Hydrobiologie. Supplementband. Large Rivers*, *11*(1), 45-60. https://doi.org/10.1127/lr/11/1996/45

Dormann, C. F. (2012). Book review: species distribution models for species distribution modellers. *Frontiers of Biogeography*, *4*(2). https://doi.org/10.21425/F5FBG12495

Gerbing, D. W. (2024). The integrated violin-box-scatter (VBS) plot to visualize the distribution of a continuous variable. *Stats*, *7*(3), 955-966. https://doi.org/10.3390/stats7030058

Hill, M. O. (1973). Diversity and evenness: a unifying notation and its consequences. *Ecology*, *54*(2), 427-432. https://doi.org/10.2307/1934352

Hill, P. (1987). A diversity of hollies. *Arnoldia*, *47*(1), 1–13. https://www.cabidigitallibrary.org/doi/full/10.5555/19870345331

Jost, L. (2006). Entropy and diversity. *Oikos*, *113*(2), 363-375. https://doi.org/10.1111/j.2006.0030-1299.14714.x

Jun, S. (2011). Marine biodiversity: Why so high?. *Biodiversity Science*, *19*(6), 611-613. https://doi.org/10.3724/SP.J.1003.2011.03227

Külköylüoğlu, O., Yılmaz, S., & Yavuzatmaca, M. (2017). Comparison of Ostracoda (Crustacea) species diversity, distribution and ecological characteristics among habitat types. *Fundamental and Applied Limnology*, *190*(1), 63-86. https://doi.org/10.1127/fal/2017/0872

Noweg, T., Grinang, J., Felix, S. E., & Kalu, M. (2024). Species composition and diversity along the elevational gradient of a low tropical hill in Teramuo Hill, Bau, Sarawak, Malaysia. *Biodiversitas: Journal of Biological Diversity*, *25*(9), 3320-3330. http://ir.unimas.my/id/eprint/46866

Python Software Foundation (2023). *Python language reference, version 3.10*. Python Software Foundation, Wilmington, Delaware, USA.

R Core Team. (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Schütte, C., & Schrimpf, I. (2002). Explaining species distribution in running water systems: larval respiration and growth of two Calopteryx species (Odonata, Zygoptera). *Archiv Fur Hydrobiologie, 153,* 217-229.https://doi.org/10.1127/archiv-hydrobiol/153/2002/217

Yang, D., & Liu, Y. (2025). Human activities unevenly disturbed climatic impacts on vegetation dynamics across natural-anthropogenic-integrated ecosystem types in China. *Habitat International*, *162*, 103451. https://doi.org/10.1016/j.habitatint.2025.103451