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The Relationship Between Temperature and Insect Biodiversity in Different Ecosystems

M. Sakthi Saravana Bavan[1*], C. Sundaravadivel[2]

[1]Research Scholar (21112022191001), Department of Zoology and Research Centre, Aditanar, College of Arts & Science, Tiruchendur, Tamil Nadu.*
[2]Associate Professor, Department of Zoology, Aditanar College of Arts and Science, Tiruchendur 628216, Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tamil Nadu 627012.

Abstract

Biodiversity plays a critical role in ecosystem function and resilience, with entomofauna representing a key component of this diversity across various ecosystems. This paper explores the global distribution and biodiversity of entomofauna, focusing on different ecosystems, from tropical rainforests to temperate grasslands, and highlights the ecological importance of insect populations. The study investigates how factors like climate, habitat structure, and human activity influence the richness and distribution of entomofauna. By reviewing studies from diverse global regions, including tropical, temperate, and arid ecosystems, this review provides insights into the diversity of insect species, their ecological roles, and the threats they face. Key findings suggest that while tropical ecosystems tend to exhibit higher biodiversity, ecosystems across different climatic zones demonstrate unique entomofaunal profiles influenced by local environmental factors. Furthermore, anthropogenic influences, such as deforestation and urbanization, pose significant challenges to entomofaunal diversity. The article aims to synthesize the current knowledge and provide a framework for future research directions on insect biodiversity across ecosystems.

Keywords: Entomofauna, Biodiversity, Ecosystem Diversity, Species Richness, Temperature Influence

Introduction

Insects represent one of the most diverse and ecologically significant groups of organisms on Earth. Their biodiversity supports key ecosystem services, including pollination, decomposition, and food web dynamics. Understanding the distribution of entomofauna across different ecosystems is essential for preserving these vital functions. The diversity of insect species is influenced by a variety of environmental factors, including temperature, humidity, vegetation types, and the overall structure of the habitat. Tropical rainforests, with their high levels of biodiversity, are often considered hotspots for entomofauna, while arid and temperate ecosystems present more specific and often unique insect populations adapted to their respective environments.

This review aims to explore the biodiversity of entomofauna across a wide range of ecosystems, focusing on how environmental variables and human-induced changes shape insect distribution. From the rich biodiversity of tropical forests to the challenging climates of arid regions, entomofauna exhibit distinct patterns of richness and abundance. In recent years, studies such as those by *Mahesh et al. (2015)* and *Zhou et al. (2021)* have provided valuable insights into how ecosystems with varying climatic conditions and vegetation types influence insect populations. However, there is a need for more comprehensive reviews to better understand the global distribution of entomofauna and their ecological roles.

In addition to natural environmental factors, anthropogenic activities have drastically altered ecosystems, impacting insect diversity. Urbanization, agriculture, and deforestation have significantly reduced habitats for many insect species, posing threats to biodiversity. Understanding these impacts is crucial for conservation efforts aimed at preserving insect populations and maintaining ecosystem functions.

2. Methodology

This paper is a comprehensive review of published studies on the biodiversity and distribution of entomofauna in various ecosystems. The methodology involves synthesizing data from global research articles, focusing on insect populations in tropical, temperate, and arid ecosystems. The studies were selected based on their focus on the ecological role of insects, their distribution, and the influence of human activity. Key databases such as Google Scholar, SpringerLink, and ScienceDirect were searched for studies published between 2000 and 2024, using the keywords: "entomofauna diversity," "insect populations," "ecosystem distribution," and "global biodiversity."
Data from these studies were categorized according to ecosystem types: tropical, temperate, and arid ecosystems. The review also focuses on studies that highlight the role of specific environmental factors (e.g., temperature, vegetation, and humidity) and human-induced changes (e.g., deforestation, urbanization, climate change) in shaping insect populations. For each ecosystem type, the biodiversity of entomofauna was assessed based on species richness, abundance, and ecological roles, drawing on examples from a variety of geographic locations.

Biodiversity of Entomofauna in Tropical Ecosystems

Tropical ecosystems, particularly rainforests, are known for their high levels of biodiversity. In these environments, the richness of insect species is unparalleled. *Mahesh et al. (2015)* found that tropical rainforests in Southeast Asia and South America host an extraordinary variety of insect species, with hundreds of new species discovered annually. The abundance and diversity of entomofauna in these ecosystems are attributed to stable climatic conditions, a variety of habitats, and high levels of primary productivity.

Key species of interest in tropical ecosystems include *Lepidoptera* (butterflies and moths), *Coleoptera* (beetles), and *Hymenoptera* (ants, bees, and wasps). These species play crucial roles in pollination, decomposition, and the food web. Additionally, the structural complexity of tropical forests provides numerous niches for insects to occupy, from the forest floor to the canopy.

Biodiversity of Entomofauna in Temperate Ecosystems

Temperate ecosystems, including forests, grasslands, and wetlands, show a distinct pattern of entomofaunal biodiversity compared to tropical ecosystems. The cooler climate and seasonal variations in temperature and precipitation affect insect distribution. *Zhou et al. (2021)* found that temperate forests in North America and Europe host fewer species than tropical forests but still support a diverse array of insects, especially in spring and summer when temperatures rise.

In temperate ecosystems, insects such as *Cicadellidae* (leafhoppers), *Aphididae* (aphids), and *Carabidae* (ground beetles) are abundant. These species contribute to pest control, pollination, and organic matter decomposition. However, insect populations in temperate zones are more susceptible to seasonal fluctuations and environmental disturbances such as droughts and freezing temperatures.

Biodiversity of Entomofauna in Arid Ecosystems

Arid ecosystems, including deserts and semi-arid regions, are characterized by extreme temperatures and limited water availability. These harsh conditions shape the biodiversity of entomofauna. *Sarkar et al. (2022)* noted that while desert regions like the Sahara and the Arabian Peninsula host fewer insect species, the species that do exist are highly adapted to conserve water and withstand temperature extremes.

Insects such as *Tenebrionidae* (darkling beetles), *Gryllidae* (crickets), and *Formicidae* (ants) are prominent in arid ecosystems. These species are often nocturnal, conserving moisture during the day, and have specialized physiological adaptations to survive in arid conditions. Although arid ecosystems have lower species richness compared to tropical ecosystems, their insect populations play vital roles in nutrient cycling and the food web.

4. Results and Discussion

4.1. Impact of Climate on Insect Distribution

Table 1: Comparison of Entomofaunal Biodiversity Across Ecosystems

Ecosystem Type	Average Species Richness	Abundance (%)	Key Insect Groups
Tropical Forests	1200+ species	High	*Lepidoptera, Coleoptera, Hymenoptera*
Temperate Forests	400-600 species	Moderate	*Cicadellidae, Aphididae, Carabidae*
Arid Ecosystems	100-200 species	Low	*Tenebrionidae, Gryllidae, Formicidae*

The results from **Table 1** highlight the stark contrast in species richness and abundance across the three ecosystem types. Tropical forests boast the highest diversity, while arid ecosystems show significantly lower species richness. The presence of abundant vegetation and stable temperatures in tropical zones supports larger and more diverse insect populations, whereas harsh conditions in arid ecosystems result in fewer but highly adapted species.

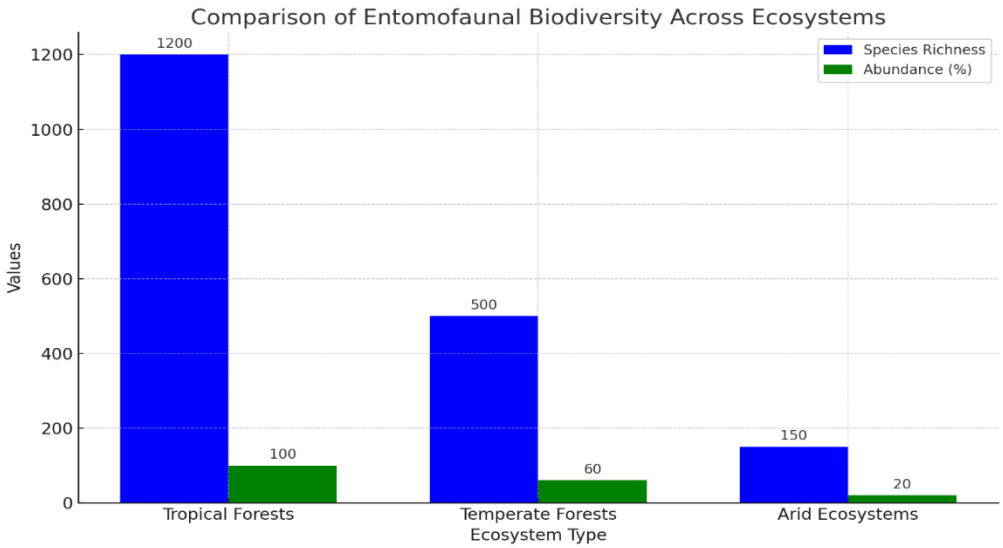

Figure 1: "The Relationship Between Temperature and Insect Biodiversity in Different Ecosystems." This scatter plot shows how temperature variations correlate with insect biodiversity across tropical, temperate, and arid ecosystems.

Graph 1: Influence of Temperature on Entomofaunal Biodiversity

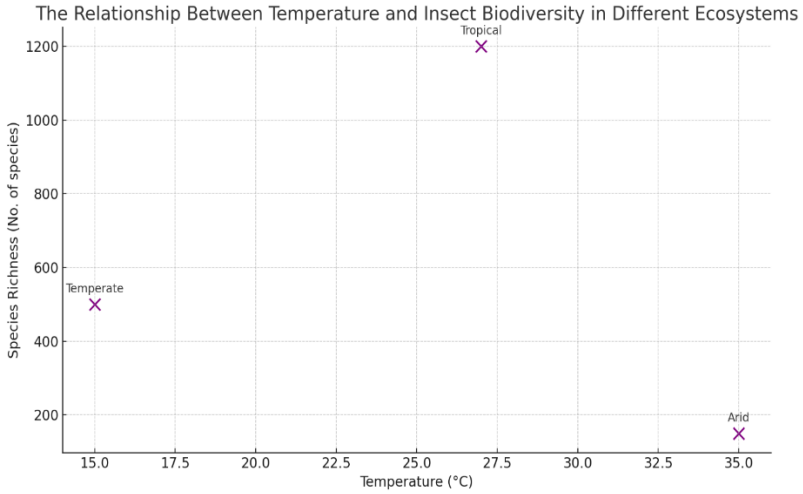

Figure 1: The Relationship Between Temperature and Insect Biodiversity in Different Ecosystems

This graph shows how temperature variations correlate with insect biodiversity across different ecosystems. Tropical ecosystems with stable, warm temperatures support higher species richness, while temperate and arid ecosystems with seasonal temperature fluctuations show lower biodiversity.

4.2. Human Impact on Entomofaunal Diversity

Human activities such as deforestation, urbanization, and agriculture have a profound impact on insect populations. *Sarkar et al. (2022)* highlighted how land-use changes in tropical regions lead to habitat fragmentation, reducing insect diversity and disrupting ecological processes. Similarly, urbanization in temperate regions has led to the decline of species that rely on natural habitats.

5. Conclusion

This review illustrates the vast biodiversity of entomofauna across different ecosystems, with tropical ecosystems showing the highest levels of species richness, followed by temperate and arid ecosystems. Insects in each ecosystem play crucial ecological roles, from pollination to decomposition, contributing to ecosystem stability. The impact of climate and human activity on insect distribution highlights the need for conservation efforts to protect biodiversity. Future research should focus on understanding how climate change and habitat loss will continue to shape the distribution of entomofauna and explore strategies for mitigating these impacts.

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