



Insect Ecology: The Backbone of Biodiversity

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Insects play a fundamental and irreplaceable ecological role in the intricate web of biodiversity and ecosystems. They constitute more than half of the known species on Earth, with millions possibly yet to be discovered. This vast insect diversity underscores their ecological importance and highlights their ubiquitous presence in almost every terrestrial and freshwater habitat. With their astounding diversity and abundance, insects have evolved to occupy a wide range of ecological niches and perform vital functions that sustain life on Earth. The ecological significance of insects arises from their varied ecological roles and interactions within ecosystems. The ecological significance of insects arises from their varied ecological roles and interactions within ecosystems. With millions of species found in almost every terrestrial and aquatic habitat, insects are the most varied group of animals on Earth. But the precise quantity of insects. The number of species is still unknown; estimates range from 5.5 million to 7 million. According to the Secretariat report of the Convention on Biological Diversity (2020), scientists have officially identified and described about a million bug species. Just 20% of the projected total insect population is represented by this. As pollinators, decomposers, and a source of food for other animals, insects play essential roles in the ecosystem. Because of the many factors that contribute to their remarkable diversity, insect biodiversity is truly unique. The majority of insect species are still poorly known and understudied despite their significance (Footit and Alder, 2009). Exploring the intriguing world of these little creatures is crucial to understanding the complexity and significance of insect biodiversity. Conservation of insects in urban environments is a key global challenge (Luke *et al.*, 2023). The continued expansion of urban areas across the globe has raised concerns about how this impacts biodiversity and the field of urban ecology has grown rapidly in recent decades. Much less is known of the ecology and diversity of invertebrates in urban environments, particularly for taxa and systems other than insect pests or disease vectors (Rega-Brodsky *et al.*, 2022). Improving knowledge of this critical component of urban ecosystems is crucial to understanding functional ecology processes and to assess and manage impacts of urbanization. In particular, understanding the ecological filtering process in an urban context, essentially which species thrive in urban environments and why (Gathof *et al.*, 2022), is critical to inform context-specific urban management strategies, actions and policies that effectively support biodiversity and maintain the ecosystem services that urban green spaces can provide. Historically, the ecology of most urban insect species, especially those dwelling in patches or fragments of greenspace, has remained largely unexplored as research has focused on insects of economic importance.

Importance of Insect Ecology

By highlighting the vital services that insects provide, such as pollination by bees, butterflies, and beetles, which supports food production and wild plant reproduction; natural pest management through an understanding of predator-prey relationships, which enables the development of eco-friendly pest control strategies; and biodiversity conservation, which reveals how insects maintain species richness and ecological resilience, insect ecology plays a crucial role in sustaining ecosystems and human livelihoods. Additionally, by decomposing organic matter and improving the soil, decomposer insects like termites and dung beetles aid in the cycling of nutrients, and their dual functions as predators and prey support the stability of food webs in both terrestrial and aquatic habitats. Insects also serve as sensitive bioindicators of climate change and environmental degradation due to their rapid responses to habitat shifts, and their study supports sustainable agriculture by promoting the use of beneficial species such as pollinators and parasitoids. Furthermore, research into disease-transmitting insects like mosquitoes and flies is vital for managing the spread of infections in both humans and animals, reinforcing the far-reaching importance of insect ecology in environmental and public health contexts.

Types of Insect Ecology

Types of Insect Ecology can be broadly categorized based on the focus of interaction and ecological roles.

Evolutionary Ecology: examines how ecological interactions influence the evolution of insect species and features throughout time.

Chemical Ecology: Studies how insects use chemical signals (semiochemicals like pheromones and kairomones) to interact with each other and their environment.

Agroecology (Agricultural insect ecology): Examines insect roles in agroecosystems, including pollinators, pests, and natural enemies, and how to manage them sustainably.

Population Ecology: Focuses on insect population dynamics, such as growth rates, birth and death rates, and factors influencing population sizes.

Behavioural Ecology: examines how ecological elements like mating, feeding, and communication (including pheromones) affect insect behavior.

Community Ecology: Studies how insect species interact within communities, including predator-prey relationships, competition, and symbiosis.

Physiological Ecology: Focuses on how insect physiology (e.g., respiration, thermoregulation) environmental conditions.

Insect ecology: Is backbone of biodiversity ?

Yes, insects are considered the backbone of biodiversity because they are the most diverse group of organisms on Earth and play indispensable roles in maintaining ecological balance. Insects are often described as the backbone of biodiversity because they constitute the vast majority of known animal species over 80% of terrestrial species, with beetles alone representing about 25% of all animal species and they underpin ecosystem structure through multiple indispensable roles: pollinating roughly 75–80% of flowering plants (including more than a third of global food crops), decomposing organic material into nutrients, aerating and enriching soil. Insects serve as critical food items for vertebrates, such as shrews, moles, hedgehogs, anteaters, lizards, amphibians, bats, birds, and fish. Insects act as natural agents of pest control, maintaining on-farm ecological balance. Insects fertilize and stabilize soil by increasing soil organic matter, and their decline has far-reaching consequences for all plants and animals in terrestrial ecosystems. Pesticides leaching into water bodies have caused up to a 42% difference in biodiversity between non-contaminated and contaminated streams, severely affecting species like dragonflies, stoneflies, and mayflies. Although other factors such as urbanization, deforestation, monoculture, and industrialization may have contributed to the decline in insect species Dr Uniyal attributed the alarming reduction primarily to human-induced environmental changes. "Excessive artificial night lighting, from our villages to our sprawling metropolitan areas, is having the most devastating impact on the fireflies'

delicate life cycle," the six legged companions who are backbone of ecology are at threat. Their extraordinary functional diversity contributes resilience, stability, and productivity across ecosystems (ranging from forests to farmland to freshwater habitats), and their decline documented in regions where insect biomass has fallen by 75% or more is triggering cascading ecological collapse, including dramatic losses of birds and other insect-dependent species. Insects are great indicators of the health of the environment and the integrity of ecosystems. Changes in insect populations can be early indicators of environmental disturbances because of their sensitivity to changes and quick reaction to changes in their habitats, habitat quality, pollution, and climate. Insect population declines can indicate possible ecological imbalances and the health of larger ecosystems. They can also be a symptom of pollution, habitat loss, pesticide use, and the effects of climate change. Scientists can evaluate the condition of ecosystems, direct conservation efforts, and put policies in place to lessen environmental risks by keeping an eye on insect populations and their diversity.

Needs for Insect population conservation

Insect population conservation is crucial for ecosystem health and biodiversity. Insects play vital roles in pollination, decomposition, and as food sources, supporting agriculture and wildlife. About 87 percent of all plant species require animal pollination, with insects providing the majority of it (Ollerton et al 2011). However, habitat loss, pesticide use, climate change, and pollution threaten insect populations worldwide. Declining insect numbers can disrupt ecosystems, impacting plant reproduction, food chains, and ecosystem services. Conserving insects involves protecting habitats, reducing pesticide use, promoting sustainable agriculture, and raising awareness about their importance. Efforts to safeguard insect populations can help maintain ecosystem balance, ensure food security, and preserve biodiversity. Recent studies further highlight the critical importance of insect pollinators in various aspects. For global food security, research by Potts *et al.* (2016) estimates that insect pollinators contribute to the production of 35% of the world's food crops, underscoring their vital role in ensuring the stability of global food supplies. In terms of plant diversity, insect pollination promotes the diversification of plant communities, leading to richer and more resilient ecosystems (Ollerton *et al.*, 2019). Additionally, the economic benefits of insect pollination are estimated to be in the trillions of dollars annually, highlighting the immense financial impact of these tiny creatures on agriculture and food production (Gallai *et al.*, 2009).

Conclusion

As we come to the end of a look into the untold wonders of insect biodiversity, it is clear that these tiny organisms are extremely important to our comprehension of the natural world, from their complex behaviors and potential for medical and technological advancements to their crucial role in pollination and nutrient cycling. In order to maintain ecosystems and the sustainability of our planet, it is critical to acknowledge the wonder and significance of these amazing animals and to accept the necessity of their conservation and protection.

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