

## Insect Ecology: The Backbone of Biodiversity

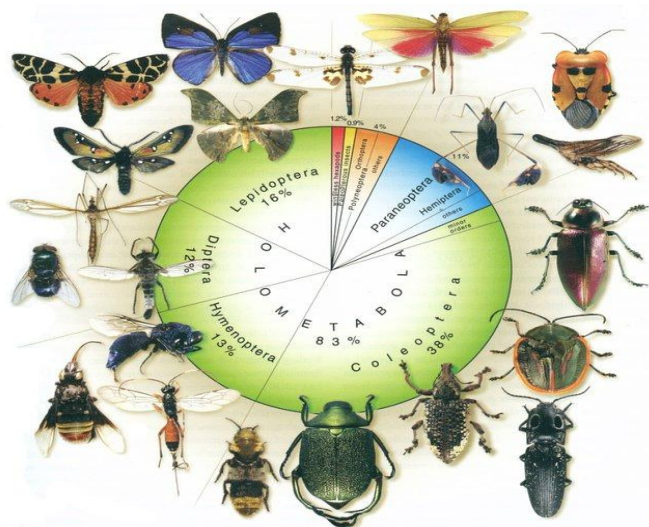
Nivedita Choori\*, Varshamrutha D Jepi and Akshata Hattiholi

Ph.D. Scholar, Department of Entomology, UAS, Dharwad-580005, Karnataka, India

Corresponding Author: [niveditachoori03@gmail.com](mailto:niveditachoori03@gmail.com)

### Introduction

Insect Ecology is the scientific study of how insects interact with each other, with other organisms, and with their environment. It examines relationships such as predation, parasitism, mutualism, competition and the role of insects in ecosystems. These interactions are influenced by factors like climate, habitat, food sources, and chemical signals like pheromones. Insect ecology is crucial because insects play key roles in pollination, nutrient cycling, food webs, and biological control. Understanding insect ecology helps in biodiversity conservation, sustainable agriculture and managing pests without harming beneficial species. It forms the backbone of ecological balance and biodiversity maintenance.



### Types of insect ecology

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

1. **Population Ecology:** Focuses on insect population dynamics, such as growth rates, birth and death rates, and factors influencing population sizes.
2. **Community Ecology:** Studies how insect species interact within communities, including predator-prey relationships, competition, and symbiosis.
3. **Behavioural Ecology:** Explores how insect behaviour is influenced by ecological factors, such as mating, foraging, and communication (e.g., pheromones).
4. **Chemical Ecology:** Studies how insects use chemical signals (semiochemicals like pheromones and kairomones) to interact with each other and their environment.
5. **Agroecology (Agricultural insect ecology):** Examines insect roles in agroecosystems, including pollinators, pests, and natural enemies, and how to manage them sustainably.
6. **Evolutionary Ecology:** Studies how ecological interactions drive evolutionary changes in insect traits and species over time.
7. **Physiological Ecology:** Focuses on how insect physiology (e.g., respiration, thermoregulation) adapts to environmental conditions.

### Importance of Insect Ecology

Insect ecology plays a pivotal role in sustaining ecosystems and human livelihoods by highlighting the crucial services that insects provide, such as pollination by bees, butterflies, and beetles that supports food production and wild plant reproduction; natural pest management through understanding predator-prey relationships, which enables the development of eco-friendly pest control strategies; and biodiversity conservation, by revealing how insects maintain species richness and ecological resilience. Additionally, decomposer insects like termites and dung beetles contribute to nutrient cycling by breaking down organic matter and enriching the soil, while their roles as both predators and prey help stabilize food webs in terrestrial and aquatic environments. 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.

### **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, naturally regulating pest populations via predation and parasitism, and forming the base of food webs that support birds, mammals, reptiles, amphibians, and fish. 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

### **Insect population decline**

Insect populations worldwide are under immense pressure from multiple interlinked threats, notably habitat loss and fragmentation due to agricultural expansion, deforestation and urban sprawl, which remove the microhabitats many insects depend on; intensive pesticide and chemical pollution, especially neonicotinoid insecticides and herbicides, which harm non-target species by impairing survival, reproduction, navigation, and immune function; climate change, which disrupts phenology, ranges, rainfall regimes, and temperature-sensitive life cycles, causing mismatches between insects and their host plants or modifying predator–prey dynamics; light, air, and noise pollution, which especially affect nocturnal insects like moths by disorienting them or disturbing essential behaviors; and invasive species or pathogens, which compete with or prey on native insects and alter ecosystem balance. Together, these factors have driven documented declines such as a 22 % decrease in U.S. butterfly populations from 2000–2020 and reductions exceeding 70–80 % in flying insect biomass in reserves, painting a global picture of insect collapse that even protected habitats are not spared.



### **Conservation of Insect population**

**Insect conservation** is the protection and management of insect species and their habitats to prevent population declines and extinctions. Insects are vital for ecosystem functioning, yet many are threatened due to habitat loss, pollution, climate change, pesticides, and invasive species.

### **Why Insect Conservation is Important:**

1. **Pollination:** Insects like bees, butterflies, and beetles pollinate crops and wild plants, supporting global food security and biodiversity.
2. **Food Web Support:** Insects are a food source for birds, amphibians, reptiles, and mammals.
3. **Nutrient Cycling:** Decomposers like dung beetles and termites recycle organic matter, enriching soil health.
4. **Natural Pest Control:** Predatory and parasitic insects regulate pest populations, reducing the need for chemical pesticides.
5. **Biodiversity Maintenance:** Insects form the majority of terrestrial biodiversity and help maintain ecological balance.

## Conclusion

Insects are vital components of ecosystems, playing key roles in pollination, decomposition, nutrient cycling, natural pest control, and as a food source for many organisms. Insect ecology helps us understand these roles and the factors affecting insect populations. Conservation of

insects is crucial for maintaining biodiversity and ecological balance. With growing threats such as habitat destruction, pesticide use, and climate change, urgent and informed conservation efforts are needed. By protecting insect diversity and their habitats, we ensure the sustainability of ecosystems and the well-being of future generations.

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