

The Role of Insects in Maintaining Ecosystem Balance and Biodiversity

Redsway Maramis¹, Joice J.I. Rompas^{2*}

¹Faculty of Agriculture, Sam Ratulangi University, Manado

²Faculty of Animal Husbandry, Sam Ratulangi University, Manado

*Email: joicerompas@unsrat.ac.id

ABSTRACT

*Insects are the most diverse group of organisms on Earth and play a crucial role in maintaining ecosystem balance. This study aims to examine the role of insects in supporting ecosystem stability and biodiversity. The research employs a qualitative descriptive approach through a literature review of relevant scientific journals, books, and research reports. The results indicate that insects perform essential ecological functions as pollinators, biological control agents, decomposers, and components of food chains. Pollinating insects, such as the honeybee (*Apis cerana*), play a significant role in enhancing plant reproduction and sustaining ecosystem productivity. In addition, predatory and parasitoid insects contribute to natural pest control, while detritivorous insects support decomposition processes and nutrient cycling. Furthermore, insects serve as important indicators of environmental health. The decline in insect populations due to human activities—including excessive pesticide use, climate change, and habitat destruction—can disrupt ecosystem balance and reduce biodiversity. In conclusion, insects play a vital role in maintaining ecosystem stability. Therefore, conservation efforts and sustainable environmental management are necessary to preserve insect populations and their ecological functions.*

Keywords: *insects, ecosystem, biodiversity, pollination, biological control*

INTRODUCTION

Insects are the most species-rich group of organisms on Earth and play a vital role in maintaining ecosystem stability. In the study of ecology, insects occupy various trophic levels and are involved in complex biological interactions. They are not merely components of the ecosystem but also primary drivers of various ecological processes (Kalita & Das, 2023).

Insects perform several critical functions, such as pollination, organic matter decomposition, biological control, and serving as integral parts of the food chain. In the pollination process, insects like bees, butterflies, and flies facilitate the reproduction of flowering plants, which forms the foundation of ecosystem sustainability and food security (Putri & Shifah, 2025). A notable example is the *Apis cerana* bee, which serves as an essential pollinator in tropical regions.

Furthermore, detritivorous insects assist in the decomposition of organic matter, supporting nutrient cycles in the soil. This process is vital for maintaining soil fertility and ecosystem productivity (Dangles & Crespo-Pérez, 2020). Conversely, predatory and parasitoid insects act as natural regulators of pest populations, helping to maintain the population balance within an ecosystem (Suman et al., 2024).

Insect diversity also contributes significantly to overall biodiversity. High insect diversity reflects a healthy and stable ecosystem. Conversely, a decline in insect populations can serve as an indicator of environmental disturbances, such as pollution, climate change, and habitat destruction (Ramadhan et al., 2021).

However, insect populations currently face serious threats from human activities, including excessive pesticide use, deforestation, and land-use changes. A decline in insect populations could have widespread impacts, including disrupted pollination and increased pest

outbreaks. Therefore, an in-depth study of the role of insects in maintaining ecosystem balance and biodiversity is necessary as a basis for sustainable conservation and environmental management.

This study examines the vital role of insects as the most diverse group of organisms in maintaining ecosystem stability and biodiversity. Using a qualitative descriptive approach through literature review, the research focuses on identifying insect ecological functions and the consequences of their declining populations on environmental balance. Theoretically and practically, this analysis aims to broaden ecological insights while serving as a foundation for the public and government to formulate sustainable conservation policies and environmental management.

From an ecosystem perspective, insects from the phylum Arthropoda act as highly adaptive biotic components and crucial indicators of environmental health. Their primary roles include serving as pollinators that facilitate plant reproduction—such as the *Apis cerana* bee—and acting as biological control agents through predatory and parasitoid behaviors that naturally suppress pest populations. Furthermore, detritivorous insects support nutrient cycling by decomposing organic matter, while their position within the food web ensures a steady energy flow for various higher-level organisms.

The extensive contribution of insects proves that their species diversity directly influences global biological resilience. However, human activities such as excessive pesticide use and habitat destruction pose serious threats that can trigger food chain imbalances and reduced ecosystem productivity. Consequently, collaborative efforts in habitat preservation and the implementation of eco-friendly agriculture are essential to guarantee the continuity of insect ecological functions and ensure a more stable future for global biodiversity.

METHODOLOGY

This study utilizes a qualitative descriptive approach centered on the literature review method to provide an in-depth understanding of insect-environment interactions. The research relies exclusively on secondary data sources, drawing from a comprehensive selection of national and international scientific journals, biology and ecology textbooks, and relevant previous research reports.

The data analysis process is conducted systematically through three distinct stages: data reduction, where relevant information is selected and simplified; data display, where the gathered data is organized into a cohesive scientific narrative; and conclusion drawing, where final insights are derived based on the synthesized literature to address the research objectives.

RESULTS AND DISCUSSION

Fundamental Concepts of Insects within Ecosystems

Insects, representing a highly diverse group of organisms within the phylum Arthropoda, play an indispensable and multifaceted role in global ecological systems. From an ecological perspective, they serve as vital biotic components, engaging in complex, continuous interactions with both their abiotic surroundings and a myriad of other living organisms. Endowed with remarkable evolutionary adaptability, insects have successfully colonized virtually every conceivable terrestrial and freshwater habitat on Earth. Due to their immense species richness, population abundance, and sensitivity to environmental shifts, insect communities serve as highly reliable bioindicators, providing crucial insights when assessing the overall health, stability, and ecological integrity of an ecosystem (Kalita & Das, 2023).

The Pivotal Role of Insects as Pollinators

Pollination stands as a fundamentally critical process in the reproductive cycle of angiosperms (flowering plants), a mechanism predominantly facilitated by insect intermediaries. Diverse

taxa, including bees, butterflies, flies, and beetles, act as the primary agents of this vital ecological service. Among these, the Eastern honey bee, *Apis cerana*, emerges as a particularly significant species. Widely distributed across the Asian continent, this species is instrumental in driving agricultural success and enhancing overall plant productivity. The ecosystem service of insect-mediated pollination extends far beyond merely boosting agricultural crop yields; it is an essential driver for safeguarding plant genetic diversity and ensuring the long-term resilience of natural flora (Putri & Shifah, 2025).

Insects as Biological Control Agents

Predatory and parasitoid insects function as highly effective, natural regulators of pest populations. This ecological role is of paramount importance in maintaining the delicate balance and stability of ecological communities, particularly within the dynamic and heavily managed environments of agroecosystems.

The mechanism of biological control provided by these beneficial insects significantly mitigates the agricultural reliance on synthetic chemical pesticides, which are often detrimental to environmental health. Consequently, these insects play a foundational role in mitigating ecological damage and driving the transition toward highly resilient and truly sustainable agricultural systems (Suman et al., 2024).



Figure 1. The Ecological Roles of Insects within Ecosystems

The preceding figure delineates the vital ecological relationships between insects and their ecosystems, specifically encompassing:

1. **Pollination** Insects, notably bees such as *Apis cerana*, are instrumental in facilitating the reproductive processes of various plant species.
2. **Biological Control** Predatory insects naturally regulate pest populations, thereby maintaining delicate ecological equilibrium.
3. **Decomposition** Detritivorous insects accelerate the breakdown of decaying organic matter, effectively recycling essential nutrients back into the soil matrix.

4. Food Web Dynamics Insects serve as a primary trophic resource for a multitude of other organisms, ensuring a continuous and stable flow of energy throughout the ecosystem.
5. Biodiversity The cumulative impact of these multifaceted ecological roles directly sustains overall biodiversity and reinforces long-term environmental stability.

Insects as Decomposers

Detritivorous insects play a fundamental role in the decomposition of organic matter. They are instrumental in transforming decaying biological remains into bioavailable nutrients that can be readily reassimilated by plants. This ecological function is of critical importance in driving biogeochemical nutrient cycling and sustaining soil fertility. Without the active presence of decomposing insects, the essential recycling of materials within the ecosystem would be severely compromised (Dangles & Crespo-Pérez, 2020).

Insects in the Food Web

Insects constitute a foundational pillar within complex ecological food webs. They serve as a primary and abundant nutritional resource for a diverse array of higher-trophic organisms, including birds, reptiles, and small mammals, while simultaneously acting as predators to lower-trophic taxa. The integral presence of insects across various trophic levels ensures the stabilization of population dynamics and effectively prevents catastrophic imbalances within the ecosystem.

Insects and Biodiversity

Entomological diversity represents a critical and substantial component of global biodiversity. A high degree of insect species richness is a robust indicator of a healthy and highly stable ecosystem. Furthermore, insects mediate a wide spectrum of essential ecosystem services, ranging from pollination and organic decomposition to the regulation of other biotic populations. Consequently, the ongoing decline in insect populations poses a systemic threat, capable of triggering cascading detrimental impacts on overall biodiversity and ecological resilience (Ramadhan et al., 2021).

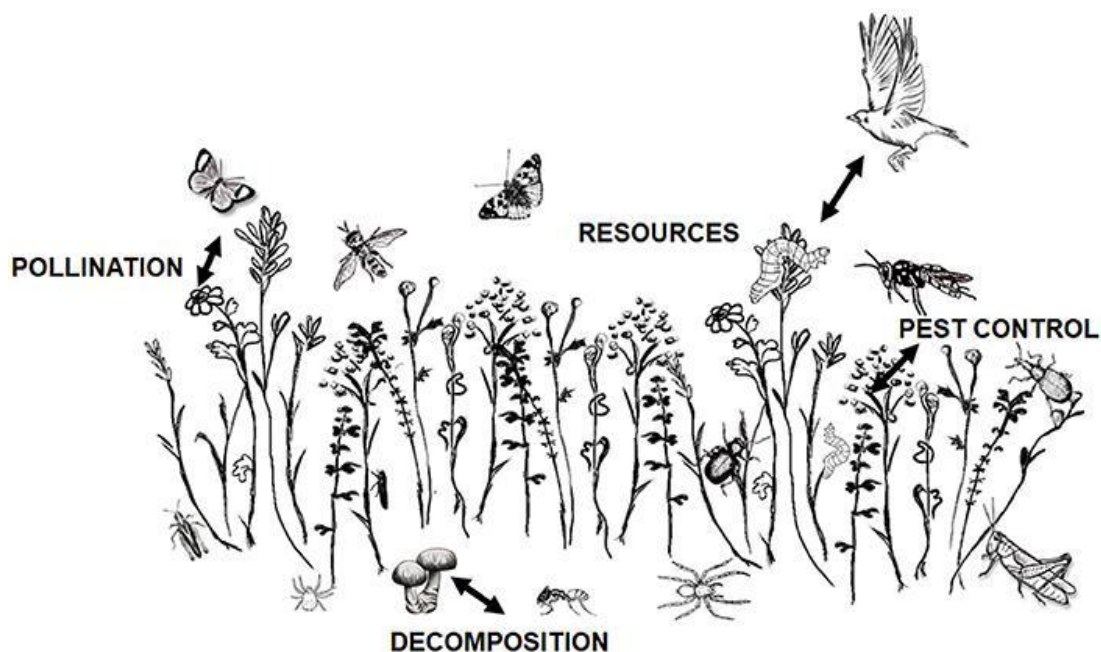


Figure 2. A Visual Representation of Insect-Mediated Ecological Interactions within a Natural Habitat

Threats to Insect Populations

Contemporary insect populations are increasingly vulnerable to a convergence of anthropogenic threats, primarily driven by accelerated climate change, the pervasive application of synthetic pesticides, and widespread habitat degradation. The alarming decline in insect biomass and diversity threatens to severely disrupt core ecosystem functions and accelerate the loss of broader biodiversity. Consequently, implementing targeted and robust conservation strategies is an urgent imperative to safeguard the long-term sustainability of insect populations and preserve their irreplaceable ecological functions.

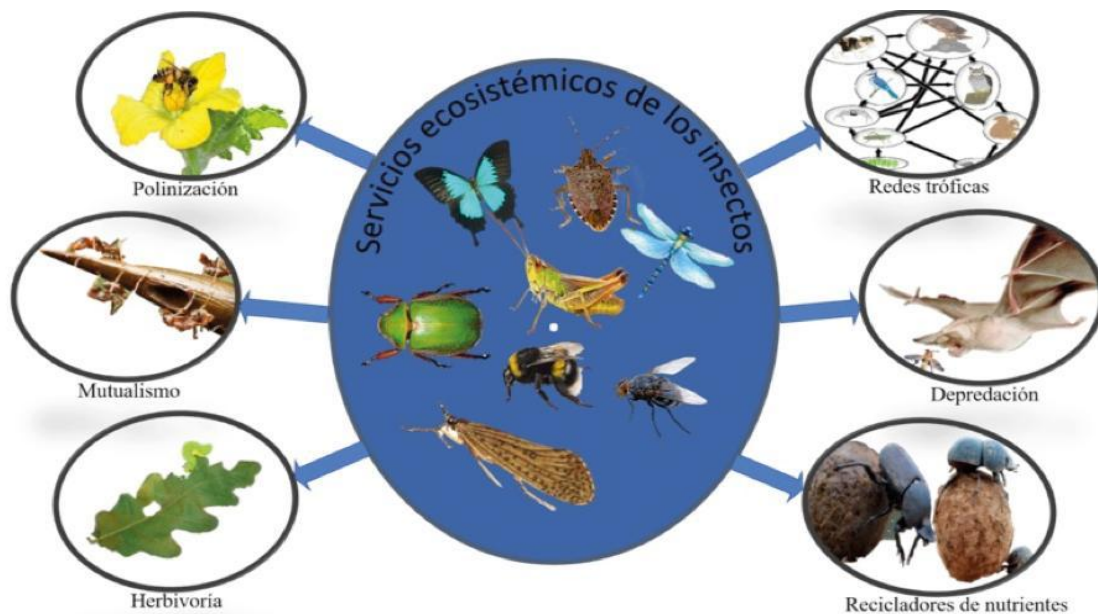


Figure 3. A Comprehensive Visual Overview of Diverse and Irreplaceable Insect-Mediated Ecosystem Services

CONCLUSION

The analysis of the role of insects in maintaining ecosystem balance leads to several fundamental conclusions. Insects are indispensable ecological drivers that fulfill critical functions as pollinators, biological control agents, and decomposers, while serving as a primary link in the food chain. Species such as the local honeybee *Apis cerana* contribute significantly to plant reproduction, which underpins ecosystem sustainability and food security. Furthermore, predatory and parasitoid insects maintain natural population equilibrium, and detritivorous species ensure soil fertility through efficient nutrient cycling. Ultimately, high insect diversity is a direct reflection of a healthy and stable ecosystem, whereas the decline in their populations due to human activity—such as pesticide misuse and habitat destruction—poses a severe threat to environmental stability.

REFERENCES

- Cardoso, P., et al. (2020). Scientists' warning to humanity on insect extinctions. *Biological Conservation*, 242, 108426.
- Dangles, O., & Casas, J. (2019). Ecosystem services provided by insects. *Annual Review of Entomology*, 64, 489-507.

- Dangles, O., & Crespo-Pérez, V. (2020). The importance of insects in ecosystems. *Current Opinion in Insect Science*, 38, 1-7.
- Didham, R. K., et al. (2020). Interpreting insect declines. *Nature Ecology & Evolution*, 4, 172-174.
- Goulson, D. (2019). The insect apocalypse. *Current Biology*, 29(19), R967-R971.
- Hallmann, C. A., et al. (2017). More than 75 percent decline in insect biomass. *PLOS ONE*, 12(10), e0185809.
- Hadi, M., et al. (2018). Peran serangga dalam pertanian berkelanjutan. *Jurnal Proteksi Tanaman*.
- Kalita, H., & Das, K. (2023). Exploring the ecological role of insects in biodiversity and ecosystems.
- Noriega, J. A., et al. (2018). Research trends in ecosystem services. *Ecological Indicators*, 93, 124-134.
- Putri, N. A., & Shifah, L. (2025). Peran serangga penyerbuk dalam produktivitas tanaman pangan. *Journal of Nature Studies*.
- Ramadhan, R. A., et al. (2021). Keragaman serangga dalam agroekosistem. *Jurnal Agroekologi*.
- Sánchez-Bayo, F., & Wyckhuys, K. A. G. (2019). Worldwide decline of insects. *Biological Conservation*, 232, 8-27.
- Seibold, S., et al. (2019). Arthropod decline in grasslands and forests. *Nature*, 574, 671-674.
- Siregar, E. H., et al. (2020). Serangga sebagai bioindikator lingkungan. *Jurnal Entomologi Indonesia*.
- Suman, A., et al. (2024). The role of insects in ecosystem balance.
- van Huis, A. (2020). Insects as food and feed. *Journal of Insects as Food and Feed*, 6(1), 1-8.