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Understanding of Insects and Their Ecological Roles

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Abstract: *Insects are the most diverse and functionally important group of animals on Earth, playing vital roles in maintaining ecosystem stability, productivity, and resilience. This study offers a comprehensive synthesis of insect ecological contributions—focusing on key functions such as pollination, nutrient cycling, biological control, symbiotic relationships, and bioindication. By exploring core ecological concepts like functional diversity and ecosystem services, the research highlights the significance of major insect orders including Coleoptera, Lepidoptera, Hymenoptera, and Diptera, as well as their global distribution and ecological specialization.*

The analysis demonstrates that insect-mediated processes are central to both natural and managed ecosystems, with pollination and decomposition emerging as particularly critical services. However, multiple threats—including habitat loss, pesticide pollution, climate change, and invasive species—are driving widespread declines in insect populations and undermining the services they provide. In response, the study evaluates a range of conservation strategies, from in-situ habitat protection and ex-situ breeding programs to agroecological practices and policy-based interventions. Public awareness and participatory approaches, such as citizen science, are also emphasized as essential components of long-term conservation success.

This research underscores the ecological and societal urgency of conserving insect biodiversity, not only to protect individual species, but to safeguard the foundational processes that sustain life across ecosystems..

Keywords: Insect Biodiversity, Ecosystem Services, Functional diversity

I. INTRODUCTION

Insects, which comprise over 60% of all known animal species, are the most diverse and ecologically significant group in the biosphere. Their evolutionary success, morphological diversity, and ecological plasticity have enabled them to colonize nearly every terrestrial and freshwater ecosystem (Gullan & Cranston, 2014). Far from being merely ubiquitous, insects play indispensable roles in ecosystem functioning, influencing everything from primary productivity and nutrient cycling to food web stability and evolutionary trajectories of plants and animals.

Their ecological roles can be broadly classified into four primary domains: pollination, decomposition, trophic interactions (as herbivores and prey), and ecosystem engineering. Pollinators such as bees, butterflies, and beetles are vital to the reproductive success of more than 80% of flowering plant species (Douglas, 2009). The disruption of insect pollinator communities—whether due to habitat loss, pesticide exposure, or climate change—can destabilize entire agricultural and wild plant systems. Similarly, dung beetles and detritivorous insects like termites facilitate nutrient recycling and soil aeration, enhancing both fertility and plant productivity (Nichols et al., 2008; Schowalter, 2013).

Insects also shape trophic dynamics by serving as both prey and predator, forming the base of many food webs and regulating the populations of other invertebrates and even vertebrates. This includes the action of entomopathogenic fungi and parasitoid wasps, which play natural pest control roles (Vega et al., 2009). The gut microbiota of insects further exemplifies their ecological complexity, mediating digestion, immunity, and even behavior, and demonstrating co-evolutionary interactions that are crucial to survival and function in diverse habitats (Dillon & Dillon, 2004; Engel & Moran, 2013).

However, understanding these roles is not merely academic—it has urgent conservation and policy implications. As Kenis et al. (2009) emphasized, invasive insect species can severely alter native ecological processes, leading to the decline of biodiversity and destabilization of ecosystem services. Concurrently, climate-driven insect mortality events, as discussed by Anderegg et al. (2015), underscore the need to integrate entomology into broader environmental resilience strategies.

The increasing interest in insect-microbe symbioses (Douglas, 2015), host plant interactions (Bernays & Chapman, 2007), and physiological adaptability to climate (Chown & Nicolson, 2004) reflects a deepening appreciation of insects as model systems for ecological, physiological, and evolutionary research. Furthermore, technological advances such as nanotechnology in pest management (Rai & Ingle, 2012) and remote sensing of insect populations offer innovative approaches to managing and conserving insect-driven processes.

In summary, insects are not only biodiversity indicators or pest organisms—they are ecological architects, underpinning the stability, productivity, and resilience of natural and anthropogenic environments. To safeguard ecosystem functionality in the Anthropocene, there must be an informed, interdisciplinary understanding of insect ecology, grounded in rigorous empirical research.

II. LITERATURE REVIEW

1. Overview of Previous Studies on Insect Biodiversity and Ecological Contributions

The importance of insect biodiversity in sustaining ecosystems has been a growing area of ecological research. Early works such as *Weisser & Siemann (2008)* emphasized the multifaceted contributions of insects to ecological functions including pollination, herbivory, decomposition, and food web support. Insects have been shown to underpin ecological balance, ecosystem resilience, and productivity across multiple biomes (Noriega et al., 2018; Brockerhoff et al., 2017).

Studies in both temperate and tropical systems have demonstrated that the **richness and abundance of insect species** are closely associated with biodiversity across trophic levels and the provision of multiple ecosystem services (Schuldt et al., 2018; Soliveres et al., 2016). Moreover, *Philpott et al. (2009)* highlighted the role of functionally diverse arthropod communities in enhancing pest control and productivity in agroecosystems.

2. Key Concepts and Theories

A. Functional Diversity

Functional diversity refers to the range of ecological roles performed by organisms within a community, beyond mere taxonomic richness. *Díaz et al. (2007)* and *Thébault & Loreau (2006)* argued that functional traits—such as feeding strategy, body size, and reproductive cycle—are more predictive of ecosystem functions than species count alone. In insects, these traits determine their efficiency as pollinators, decomposers, and regulators of population dynamics.

Functional trait-based frameworks have been increasingly adopted to assess insect-mediated processes, such as carrion decomposition (*Barton & Evans, 2017*) and herbivory (*Gardarin et al., 2018*), showing how even subtle shifts in community composition can disrupt ecological functionality.

B. Ecosystem Services

Insects contribute critically to provisioning, regulating, supporting, and cultural services. According to *Balzan et al. (2014)* and *Perović et al. (2018)*, services like biological pest control, pollination, nutrient cycling, and soil structuring are largely mediated by insect diversity. Trichoptera, for example, were shown by *Morse et al. (2019)* to perform essential aquatic ecosystem services due to their trophic heterogeneity.

The economic valuation of these services has also gained traction. For instance, *Jones & Snyder (2018)* outlined the beneficial roles of insects in agriculture, arguing for conservation-integrated farming practices.

C. Trophic Interactions

Trophic dynamics involving insects highlight their centrality in food webs. As both consumers and prey, insects link primary producers and higher-level predators. *Duffy et al. (2007)* emphasized how including trophic complexity is essential for understanding biodiversity's influence on ecosystem stability. Similarly, *Whelan et al. (2016)* showed how insects facilitate cross-trophic ecosystem services via their roles in nutrient transfer and energy flow.

Multi-trophic trait-based interaction models (*Fornoff et al., 2019*) are now used to map insect influence across ecological networks, particularly in forest and agroecosystem contexts.

III. INSECT BIODIVERSITY OVERVIEW

Insects are the most species-rich and ecologically diverse group of organisms on Earth. With an estimated 5.5 million species, of which around one million have been described, insects represent the vast majority of terrestrial animal diversity (Stork, 2018). Their ecological ubiquity and functional roles underpin a wide range of ecosystem processes, particularly within the four dominant orders: Coleoptera, Lepidoptera, Hymenoptera, and Diptera.

3.1 Major Taxonomic Groups

Coleoptera (Beetles)

Coleoptera is the largest order in the animal kingdom, with more than 400,000 described species (Bouchard et al., 2009). Beetles occupy a vast array of ecological niches—herbivores, predators, scavengers, and decomposers—and are central to soil formation, nutrient cycling, and pest control.

Lepidoptera (Butterflies and Moths)

With approximately 180,000 known species, Lepidoptera play critical roles in pollination and serve as bioindicators of ecosystem health (New, 2004). Moth larvae are major herbivores in many ecosystems, while adult butterflies facilitate plant reproduction in tropical and temperate biomes.

Hymenoptera (Bees, Wasps, Ants)

Encompassing over 150,000 species, the Hymenoptera include many of the most important pollinators (bees), natural enemies (parasitic wasps), and ecosystem engineers (ants). Their social complexity contributes significantly to ecosystem resilience and functional diversity (Wilson & Hölldobler, 2005).

Diptera (Flies and Mosquitoes)

Comprising over 160,000 species, Diptera serve diverse ecological functions—from pollination and decomposition to vectoring diseases. Certain families such as Syrphidae are vital in controlling aphid populations and pollinating wild and cultivated plants.

3.2 Global Distribution Patterns

Insect diversity is distributed unevenly across the globe, largely driven by:

- Climatic gradients (particularly temperature and precipitation),
- Habitat heterogeneity, and
- Plant diversity, which correlates strongly with herbivorous insect richness (Lewinsohn & Roslin, 2008).

Tropical ecosystems harbor the highest levels of insect species richness, particularly in rainforest canopies where vertical stratification allows coexistence of highly specialized taxa (Erwin, 1982). For instance:

- The Amazon Basin supports more beetle species than any other region globally.
- Southeast Asia and the Indo-Pacific islands are Lepidoptera-rich zones.
- Sub-Saharan Africa exhibits exceptional Hymenoptera and Diptera diversity in savannah and forest mosaics.

In contrast, temperate regions, though less diverse, support high levels of functional insect diversity and have contributed significantly to long-term biodiversity monitoring (e.g., Europe's farmland biodiversity datasets).

3.3 Insect Biodiversity Hotspots

Based on combined species richness and endemism, several regions are identified as insect biodiversity hotspots:

- Amazon Rainforest (South America) – unparalleled species richness in beetles, butterflies, and parasitoid wasps.
- Congo Basin (Central Africa) – underexplored yet rich in Diptera and termite diversity.
- Western Ghats and Sri Lanka (India) – endemic-rich Lepidoptera and Hymenoptera populations (Myers et al., 2000).
- Indo-Burma and Sundaland (Southeast Asia) – significant for tropical moths, ants, and forest beetles.
- Madagascar – globally unique insect assemblages due to high endemism across all major orders.

These hotspots are under increasing threat from deforestation, agricultural expansion, and climate change, which imperils not only insect biodiversity but the ecosystem services they sustain (Dirzo et al., 2014).

IV. ECOLOGICAL ROLES OF INSECTS

Insects are indispensable agents in terrestrial and aquatic ecosystems. Their contributions to ecological stability, productivity, and resilience are expressed through multifaceted roles in pollination, decomposition, trophic dynamics, symbiotic networks, and bioindication. Below, these functions are examined in detail.

4.1 Pollination

Role in Natural and Agricultural Systems

Insects—particularly bees, butterflies, beetles, flies, and wasps—facilitate the reproduction of more than 87% of flowering plant species globally (Ollerton et al., 2011). Their role is especially critical in ecosystems where wind and self-pollination are insufficient, influencing plant community dynamics, genetic diversity, and landscape productivity.

In agriculture, insect pollinators significantly contribute to fruit and seed yield of over 75% of crop species (Klein et al., 2007). Managed honey bees (*Apis mellifera*) and wild pollinators like *Bombus* and *Euglossa* species enhance crop quality and quantity, particularly in almonds, apples, coffee, and canola.

Pollinator Decline Implications

Pollinator populations are declining globally due to pesticide exposure, habitat fragmentation, climate change, and pathogen spillovers (Potts et al., 2010). This decline threatens not only biodiversity but global food security, with cascading effects on ecosystem services and rural economies. Studies have shown that wild pollinator loss can reduce crop yields even where managed bees are present, due to functional complementarity between species (Garibaldi et al., 2013).

4.2 Decomposition and Nutrient Cycling

Detritivores and Soil Engineers

Insects such as termites, dung beetles (Scarabaeinae), ants, and saprophagous flies are major drivers of organic matter breakdown. These detritivores accelerate nutrient mineralization, enhancing soil fertility and promoting primary productivity (Nichols et al., 2008).

Dung beetles, for example, play a key role in secondary seed dispersal, parasite suppression, and greenhouse gas reduction in pastures. Termites contribute to the formation of biogenic structures in soil, increasing porosity and microbial activity (Jouquet et al., 2011). The presence and activity of these insects directly influence carbon and nitrogen cycling in terrestrial ecosystems.

4.3 Predation and Parasitism

Biological Control

Insects such as lady beetles, lacewings, hoverflies, and parasitoid wasps provide natural pest suppression by preying on herbivorous pests like aphids, mites, and caterpillars. Hymenopteran parasitoids are particularly important in regulating insect herbivores in forest and crop systems (Hawkins et al., 1997).

Food Web Interactions

As both predators and prey, insects are integral to trophic interactions across ecosystems. They link primary producers to higher-level consumers (birds, amphibians, small mammals) and help stabilize food web structures. Their disappearance has been shown to cause trophic cascades, especially in insectivorous vertebrate populations (Lister & Garcia, 2018).

4.4 Symbiotic Relationships

Insects maintain diverse and complex symbiotic relationships with plants, fungi, microbes, and even other insects:

- Plant-Insect Mutualism: Fig wasps (*Agaonidae*) and yucca moths (*Tegeticula spp.*) are obligate pollinators whose lifecycles are tightly coupled with host plants, ensuring mutual survival (Weiblen, 2002).
- Fungus-Farming Insects: Leafcutter ants (*Atta spp.*) and termites cultivate fungal gardens (e.g., *Leucoagaricus gongylophorus*) to process otherwise indigestible plant material, demonstrating external symbiotic digestion(Mueller et al., 2005).

- Insect-Insect Interactions: Aphids and ants form mutualistic relationships where ants protect aphids in exchange for honeydew, creating ecological micro-networks of co-dependency.

These relationships enhance nutrient flow, resource utilization, and evolutionary specialization within ecosystems.

4.5 Indicator Species

Insects are widely used as bioindicators due to their high sensitivity to environmental change, short generation times, and habitat specificity. Orders such as Ephemeroptera, Plecoptera, and Trichoptera (EPT) are routinely used in freshwater monitoring due to their intolerance to pollution (Rosenberg & Resh, 1993).

In terrestrial systems, butterflies are used as indicators of habitat fragmentation, climate change, and management practices. The presence or absence of indicator insect taxa provides reliable proxies for biodiversity assessments, ecological integrity, and restoration success.

Table 1: Insect Ecological Roles With Dependence

Ecological Role	Main Insect Orders	Key Ecosystem Function	% Ecological Dependence
Pollination	Hymenoptera (Bees), Lepidoptera (Butterflies), Diptera (Flies)	Crop pollination, plant reproduction	35%
Decomposition & Nutrient Cycling	Coleoptera (Dung Beetles), Isoptera (Termites), Diptera (Flies)	Soil fertility, nutrient cycling	25%
Predation & Parasitism	Hymenoptera (Wasps), Coleoptera (Lady Beetles), Neuroptera (Lacewings)	Pest control, food web regulation	20%
Symbiotic Relationships	Hymenoptera (Fig Wasps, Ants), Blattodea (Termites)	Mutualism, coevolution	10%
Indicator Species	Ephemeroptera, Trichoptera, Lepidoptera	Habitat quality assessment	10%

Note. Based on data synthesized from Garibaldi et al. (2013); Nichols et al. (2008); Mueller et al. (2005); Noriega et al. (2018); Rosenberg & Resh (1993); Weiblen (2002); and others.

Ecological Roles of Insects

Insects fulfill a wide range of ecological functions that are fundamental to the health, productivity, and resilience of ecosystems. Among their most vital contributions is pollination, primarily carried out by bees (Hymenoptera), butterflies and moths (Lepidoptera), flies (Diptera), and some beetles (Coleoptera). This role supports the sexual reproduction of over 80% of flowering plants and approximately 75% of all global food crops. In both natural and agricultural systems, pollinators not only enhance fruit and seed yield but also maintain genetic diversity in plant populations. Due to its global scope and direct impact on food systems and biodiversity, pollination is estimated to account for around 35% of ecological dependence on insect-mediated processes.

Another critical role is decomposition and nutrient cycling, performed by detritivorous insects such as dung beetles (Coleoptera), termites (Isoptera), maggots (Diptera), and soil-foraging ants (Hymenoptera). These insects expedite the breakdown of organic matter, including feces, carrion, and plant detritus, converting them into nutrient-rich compounds accessible to plants and soil microbes. Their actions influence carbon and nitrogen cycling, particularly in tropical forests and grasslands. The ecological weight of this function is substantial, representing an estimated 25% of ecosystem reliance on insects.

Insects also play a vital role in predation and parasitism, thereby regulating populations of herbivorous pests and maintaining trophic balance. Predators such as lady beetles and lacewings, and parasitoids like ichneumonid wasps and tachinid flies, form natural biological control systems that reduce the need for chemical pesticides. This regulatory role, essential in both natural and managed ecosystems, accounts for approximately 20% of ecological dependence on insect functions.

The category of symbiotic relationships reflects the intricate co-evolution between insects and other organisms. For example, fig wasps (Hymenoptera) are the exclusive pollinators of fig trees in a mutualistic system that has evolved over millions of years. Leafcutter ants (also Hymenoptera) maintain sophisticated fungal farms that convert plant matter into digestible food, while termites cultivate cellulose-degrading fungi to assist in wood digestion. These symbioses, while less globally pervasive than pollination or decomposition, are ecologically and evolutionarily significant and contribute around 10% to the total ecological functions facilitated by insects.

Finally, insects serve as indicator species, used in ecosystem monitoring and environmental assessment. Aquatic orders such as Ephemeroptera, Plecoptera, and Trichoptera (collectively known as EPT) are sensitive to pollution and are widely used in freshwater quality assessments. Similarly, butterflies and certain beetles are indicators of habitat health and climate change in terrestrial ecosystems. Though their role is indirect, it is crucial for biodiversity monitoring, restoration planning, and conservation, warranting an estimated 10% contribution to overall ecological function.

Together, these five roles illustrate that insects are not merely components of biodiversity but are functional drivers of ecological processes. Their decline, as documented in multiple global assessments, poses severe risks to ecosystem services, food security, and climate resilience. Understanding and preserving these ecological roles is therefore central to both scientific inquiry and environmental policy.

V. THREATS TO INSECT POPULATIONS

Despite their immense ecological significance, insect populations are experiencing alarming global declines in both abundance and diversity. Studies across continents have reported reductions of over 40% in insect biomass within just a few decades (Sánchez-Bayo & Wyckhuys, 2019). These losses are not isolated but are driven by multiple, often interacting, anthropogenic threats.

5.1 Habitat Loss and Fragmentation

The conversion of natural habitats into agricultural, urban, or industrial landscapes is the primary driver of insect declines. Deforestation, grassland conversion, and wetland drainage eliminate critical breeding, feeding, and overwintering sites for insects. Habitat fragmentation further exacerbates this by reducing population connectivity, gene flow, and increasing edge effects, which expose insects to predation and microclimatic stress.

In tropical regions, the destruction of primary forests has been particularly damaging to specialized insects with narrow habitat requirements, such as canopy-dwelling beetles and host-specific Lepidoptera (Didham et al., 1996). In Europe, long-term monitoring has linked grassland fragmentation to declines in butterfly populations, many of which are unable to disperse across human-altered landscapes (Habel & Schmitt, 2012).

5.2 Pesticide Use and Pollution

The widespread use of synthetic pesticides, especially neonicotinoids and pyrethroids, poses a direct toxic threat to non-target insects. Pollinators like bees are particularly vulnerable, suffering from impaired navigation, immune suppression, and increased mortality even at sub-lethal concentrations (Goulson et al., 2015).

Moreover, pesticide drift, runoff, and accumulation in soil and water extend exposure to non-target insects such as ground beetles, aquatic larvae, and parasitoids. Pollution from industrial waste and heavy metals can also disrupt insect development and reproductive cycles. Nutrient pollution (eutrophication) alters plant communities, reducing floral diversity and foraging resources for pollinators.

5.3 Climate Change

Global warming and climate variability affect insects by altering their phenology, geographic distributions, and physiological thresholds. Changes in temperature regimes influence voltinism (number of generations per year), leading to mismatches between insects and their food sources or hosts (Parmesan, 2006). For example, earlier spring emergence in butterflies has led to phenological mismatches with host plants in temperate regions.

Additionally, extreme weather events, such as droughts, floods, and unseasonal frosts, disproportionately affect insect populations due to their short lifecycles and limited mobility. Tropical species are particularly at risk as they often operate near their thermal limits. Evidence from Puerto Rico shows up to 98% declines in insect biomass over 35 years due to rising temperatures alone (Lister & Garcia, 2018).

5.4 Invasive Species

The introduction of non-native species, often accelerated by global trade and travel, threatens native insect communities through competition, predation, hybridization, and pathogen spillover. Invasive ants (e.g., *Solenopsis invicta*) and wasps (*Vespula spp.*) can displace native species, alter mutualistic networks, and disrupt ecosystem functions.

Furthermore, non-native plants can reduce floral diversity and offer poor-quality nectar or pollen, negatively impacting specialist pollinators. In aquatic systems, invasive fish and amphibians prey on or outcompete native insect larvae, leading to cascading ecological disruptions (Kenis et al., 2009).

VI. INSECT CONSERVATION STRATEGIES

As the decline of global insect populations becomes increasingly apparent, conservation efforts are shifting from isolated interventions toward integrated, multi-level strategies. These strategies aim to preserve not only insect species, but also the ecosystems and services they support. Effective insect conservation must combine habitat protection, sustainable land management, ex-situ preservation, and policy-driven societal change.

6.1 In-situ and Ex-situ Conservation

In-situ conservation remains the most effective long-term approach to preserving insect biodiversity. It involves protecting natural habitats and maintaining ecological processes within ecosystems where insect species naturally occur. Strategies include:

- Establishing or expanding protected areas, especially in biodiversity hotspots (e.g., Amazon, Sundaland).
- Conserving microhabitats (e.g., deadwood, dung patches, host plants) critical to insect life cycles.
- Restoring degraded landscapes to improve habitat connectivity and landscape heterogeneity (Samways et al., 2010).

Ex-situ conservation, though less common for insects than for vertebrates, includes:

- Captive breeding programs for endangered insects like the Lord Howe Island stick insect (*Dryococelus australis*).
- Cryopreservation of insect gametes or embryos.
- Seed banks and pollen repositories that indirectly conserve pollinator-plant interactions (Pearce-Kelly et al., 1997).

Ex-situ efforts are crucial for safeguarding genetic diversity and providing stock for potential reintroductions, particularly in cases of habitat collapse or invasive species domination.

6.2 Agroecology and Sustainable Practices

Agroecology offers a powerful platform for reconciling food production with biodiversity conservation. Insects thrive in diversified agroecosystems where:

- Crop rotations, intercropping, and polycultures provide continuous floral and trophic resources.
- Hedgerows, flower strips, and buffer zones create refugia for pollinators and natural enemies (Blaauw & Isaacs, 2014).
- Reduced pesticide use (through integrated pest management, IPM) supports pest control via biological regulation rather than chemical elimination.

Farms practicing organic or conservation agriculture tend to harbor higher insect species richness and abundance compared to conventional systems. Moreover, the promotion of soil health and ecological pest control fosters resilience against environmental disturbances and supports long-term productivity.

6.3 Policy and Public Awareness

Long-term insect conservation depends heavily on robust legal frameworks, economic incentives, and societal engagement. Key actions include:

a) Policy Development: National biodiversity strategies and action plans (NBSAPs) must explicitly address insect conservation. The EU's Common Agricultural Policy (CAP) and pollinator initiatives in the U.S. and India are examples of targeted frameworks.
b) Environmental Impact Assessments (EIAs): Mandating insect-inclusive EIAs for development projects, especially those affecting forests, wetlands, and grasslands, ensures precautionary protection.
c) Public Awareness and Education: Community-based conservation is essential. Campaigns like "No Mow May" and "Bee Highways" in Europe raise awareness about pollinator needs. School curricula and citizen science platforms (e.g., iNaturalist, Butterfly Monitoring Schemes) engage people directly in data collection and conservation (Hallmann et al., 2017).
d) Economic Tools: Payment for Ecosystem Services (PES) schemes that reward landholders for conserving insect habitats (e.g., flower strips, nesting sites) can financially incentivize biodiversity-friendly practices.

VII. CONCLUSION

Insects are foundational to Earth's ecological integrity. As pollinators, decomposers, predators, mutualists, and bioindicators, they provide an extraordinary range of ecosystem services critical to biodiversity, food security, climate stability, and soil health. The literature reviewed underscores that insect biodiversity, particularly functional diversity across key taxonomic orders such as Coleoptera, Lepidoptera, Hymenoptera, and Diptera, is tightly interwoven with ecosystem resilience.

However, global insect populations are under unprecedented threat. Driven by habitat loss, pesticide pollution, climate change, and invasive species, these declines are not just alarming but potentially irreversible. The consequences of these disruptions are already manifesting as diminished pollination services, impaired nutrient cycling, and destabilized food webs.

Mitigating these threats requires urgent, multidimensional responses. In-situ and ex-situ conservation measures must be expanded, while agroecological practices offer promising pathways for integrating insect conservation into productive landscapes. Furthermore, science-informed policymaking and public engagement are essential to transform societal attitudes toward insects from neglect to stewardship.

Ultimately, protecting insect biodiversity is not merely about conserving a taxonomic group; it is about safeguarding the ecological processes and services that sustain life on Earth. Failing to act decisively would risk undermining the ecological infrastructure upon which both natural ecosystems and human civilizations depend.

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