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ECOLOGICAL IMPLICATIONS ON INSECT BIODIVERSITY OF MUKUNDPUR TIGER RESERVE, SATNA (M.P.)

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ABSTRACT:

Insects form the most diverse and ecologically significant group within forest ecosystems, playing essential roles in pollination, decomposition, nutrient cycling, biological control and food-chain regulation. Mukundpur Tiger Reserve (MTR), located in the Vindhyan region of Satna district in Madhya Pradesh, represents a mosaic of dry deciduous forests, bamboo brakes, grasslands, rocky outcrops and wetland patches that support a wide array of insect species. Despite its biological importance, limited research has been conducted on insect diversity in this reserve. This study investigates the ecological implications of insect biodiversity by assessing their distribution, functional roles, habitat interactions and the environmental factors influencing their presence. The research highlights how insect diversity contributes to ecological stability and forest health and examines the major threats that risk diminishing this vital biotic component. The findings emphasize the need for sustained conservation and monitoring to maintain the ecological integrity of Mukundpur Tiger Reserve.

KEYWORDS: *Insect, Ecosystem, Biological Control and Mukundpur Tiger Reserve.*

INTRODUCTION:

Insects serve as the foundation of terrestrial ecosystems due to their immense diversity, adaptability and ecological functions. They occupy every possible ecological niche and contribute significantly to forest dynamics through processes such as pollination, herbivory, predation, parasitism and decomposition. Their sensitivity to environmental changes makes them excellent indicators of ecological stability and environmental health. Mukundpur Tiger Reserve, although renowned for charismatic megafauna like tigers, leopards, deer and birds, harbors a rich but largely unrecorded diversity of insects. The reserve's varied topography and vegetation create microhabitats that support a wide range of insect taxa. Studying insect biodiversity in this landscape is essential to understanding the functioning of its ecosystems and developing effective conservation strategies. This research explores the ecological implications of insect diversity in Mukundpur Tiger Reserve by examining their distribution patterns, ecological functions, habitat preferences, and conservation challenges.

STUDY AREA:

Mukundpur Tiger Reserve is situated in the Satna district of Madhya Pradesh, within the Vindhyan mountain ranges. The reserve spans approximately 364 square kilometers, including both core and buffer zones. Its geographical location between 24°18′–24°36′ N and 81°10′–81°25′ E gives it a landscape dominated by undulating hills, plateaus, and plains. The climate of the region is characterized by hot summers, cool winters and a monsoon season that provides most of the annual rainfall, ranging between 900 and 1100 mm. Temperatures vary widely from 8°C in winter to over 45°C in summer, and humidity levels fluctuate seasonally. The vegetation of the reserve is mainly dry deciduous, dominated by species such as *Anogeissus latifolia*, *Terminalia tomentosa*, *Madhuca indica*, *Boswellia serrata*, *Butea monosperma*, and bamboo (*Dendrocalamusstrictus*). The coexistence of dense forests, open woodlands, grasslands, and wetland pockets supports diverse faunal communities, including insects with varied ecological requirements.

OBJECTIVES OF THE STUDY:

The primary aim of this study is to analyze the ecological implications of insect biodiversity in Mukundpur Tiger Reserve. The objectives include assessing the distribution and diversity of insect groups, understanding their ecological roles, identifying environmental and anthropogenic factors influencing their populations, examining their interactions with vegetation and other fauna and proposing conservation measures to sustain insect diversity in the long term.

METHODOLOGY:

The study utilizes an ecological assessment approach supported by field observations, standard entomological methods and literature-based analysis. Various sampling techniques, including transect walks, pitfall traps, light traps, sweeping nets and dung-baited traps, were used to document different insect groups across habitats. Sampling was conducted in dense forests, open forests, bamboo patches, grasslands, wetland edges and disturbed road-side habitats to capture habitat-specific diversity. Diversity indices such as Shannon-Wiener and Simpson's Index were applied to interpret species richness, evenness and dominance patterns. Seasonal surveys were conducted to understand how climatic variations influence insect abundance across summer, monsoon and winter.

Insect Diversity in MukundpurTiger Reserve:

The insect fauna of Mukundpur Tiger Reserve includes representatives from major orders such as Lepidoptera, Coleoptera, Hymenoptera, Hemiptera, Orthoptera, Odonata, Diptera and Isoptera. Butterflies and moths thrive in open and semi-open habitats where host plants are abundant. Beetles, including dung beetles, wood borers and leaf beetles are found in forest floors, deadwood and decaying organic matter. Ants and bees dominate in both forest and open areas, playing critical roles in pollination and soil turnover. Grasshoppers and crickets inhabit grasslands and scrublands, while dragonflies and damselflies occur near wetlands and streams. Termites form an essential component of the soil ecosystem, contributing significantly to decomposition and nutrient cycling. Seasonal variations strongly influence insect activity patterns; monsoon months record the highest populations of termites, mosquitoes, moths and other humidity-dependent insects, whereas butterflies show peak diversity in summer, particularly in flowering zones.

Ecological Implications of Insect Biodiversity:

Insects play indispensable roles in maintaining the ecological balance of Mukundpur Tiger Reserve. Pollination is one of the most crucial functions, carried out primarily by bees, butterflies, flies and beetles. These pollinators ensure the reproductive success of numerous forest plants, including

Madhuca indica, *Syzygiumcumini*, *Ziziphus mauritiana*, *Butea monosperma* and various herbaceous species. A decline in pollinator populations would directly affect seed production, fruiting cycles and food availability for herbivores, thus impacting the entire food web.

Insects also contribute significantly to nutrient cycling and soil formation. Termites break down cellulose-rich plant materials and convert them into organic matter, enhancing soil fertility. Dung beetles contribute by decomposing and burying animal dung, thus aiding nutrient recycling, reducing parasite loads and improving soil aeration. Ants act as ecosystem engineers by modifying soil structure through tunneling, which facilitates water infiltration and root growth. These processes collectively strengthen soil health and promote forest regeneration.

Herbivorous insects such as caterpillars, leafhoppers and beetles influence vegetation dynamics by selectively feeding on leaves, shoots and stems. While moderate herbivory increases plant resilience and stimulates new growth, severe outbreaks can lead to temporary defoliation of forest patches. Nonetheless, such plant-insect interactions are natural components of forest ecosystems and often trigger compensatory responses in vegetation.

Predatory insects, including mantids, dragonflies, parasitic wasps and certain beetles, regulate populations of other insects and serve as natural biological control agents. For instance, dragonflies help control mosquito larvae near water bodies, while ladybird beetles reduce aphid infestations on vegetation. Decomposer insects, such as scavenger beetles and fly larvae, play vital roles in breaking down dead organic matter and animal carcasses, contributing to nutrient release and preventing disease spread.

Insects form an essential food base for higher trophic levels. Numerous reptiles, amphibians, birds and small mammals rely on insects for survival. A decline in insect populations could disrupt these food chains, causing cascading ecological effects across the reserve.

Factors Influencing Insect Biodiversity:

The richness and abundance of insects in Mukundpur Tiger Reserve are heavily influenced by habitat heterogeneity, microclimatic variables, vegetation composition and seasonal patterns. Areas with dense vegetation, high canopy cover and moist soil tend to support termites, beetles, ants and shade-loving butterflies. On the other hand, open grasslands and sunlit forest edges attract a higher diversity of butterflies, grasshoppers and pollinators. Wetland zones provide ideal habitats for dragonflies, damselflies and aquatic beetles.

Microclimate plays a significant role in insect distribution. Temperature, humidity, light intensity and soil moisture directly affect insect breeding, feeding and survival. Plant diversity also shows a strong positive correlation with insect diversity. Mixed forests and areas with abundant flowering plants record higher insect richness compared to monoculture or degraded patches.

Threats to Insect Biodiversity:

Insect biodiversity in Mukundpur Tiger Reserve faces several ecological and anthropogenic threats. Habitat disturbance resulting from tourism, road development, noise pollution and vehicular movement disrupts insect microhabitats and reduces populations of sensitive species. The spread of invasive alien species such as *Lantana camara* and *Parthenium hysterophorus* alters the composition of ground vegetation, leading to the decline of native host plants required by many insects. Pesticide drift from surrounding agricultural areas further endangers non-target insect species, particularly pollinators and predatory insects.

Climate change poses a major threat to insect diversity by altering temperature and rainfall patterns, which can disrupt breeding cycles, migration routes and plant-insect interactions. Declining wetland habitats reduce the availability of breeding sites for aquatic insects, impacting species such as

dragonflies and certain beetles. Forest fires, especially during the dry season, can destroy leaf litter, ground-dwelling insects and saprophagous communities that are crucial for nutrient cycling.

Conservation and Management Strategies:

Effective conservation of insect biodiversity in Mukundpur Tiger Reserve requires habitat protection, invasive species management and scientific monitoring. Protecting natural grasslands, controlling the spread of invasive plants, maintaining wetland areas and avoiding unnecessary road expansion are essential steps to conserve insect habitats. Long-term monitoring programs involving butterfly transects, odonate surveys, ant diversity studies and dung beetle sampling can help assess ecosystem health. Community engagement is equally important; educating local villagers about the importance of pollinators and the harmful effects of excessive pesticide use can significantly enhance conservation outcomes.

Ecological restoration through planting native flowering plants, maintaining deadwood and enhancing microhabitats can promote insect populations. Policy-level measures, including the inclusion of insects in biodiversity assessments and the creation of pollinator-friendly zones in buffer areas, can strengthen conservation efforts. Climate-resilient strategies, such as protecting water sources and promoting mixed vegetation, further support long-term insect survival.

CONCLUSION:

Insect biodiversity in Mukundpur Tiger Reserve plays a critical role in maintaining ecological balance and forest health. Their contributions to pollination, decomposition, nutrient cycling, biological control and food-web stability make them indispensable to the functioning of the reserve's ecosystems. However, increasing anthropogenic pressures, habitat degradation, climate variation and invasive species pose significant threats to these crucial organisms. Understanding the ecological implications of their diversity is essential for effective conservation planning. Sustained research, habitat management, community involvement, and ecological monitoring can ensure the long-term protection of insect biodiversity and the ecological integrity of Mukundpur Tiger Reserve.

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