

Diversity, Distribution and Ecological Role of Beetles in Different Habitats of Bilaspur Region, Chhattisgarh

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Abstract

Beetles (Order: Coleoptera) constitute the largest order of insects, exhibiting remarkable diversity across terrestrial and aquatic ecosystems. The Bilaspur region of Chhattisgarh, situated in central India, encompasses a mosaic of tropical deciduous forests, agricultural fields, urban green spaces, and riparian zones that support diverse beetle assemblages. This paper reviews the diversity, habitat-wise distribution, and ecological significance of beetles across different habitats of the Bilaspur region. A total of 15 beetle families comprising over 85 species were documented from four major habitat types: deciduous forests, agricultural croplands, urban/peri-urban areas, and wetland/riparian habitats. Scarabaeidae emerged as the most species-rich family, followed by Chrysomelidae, Cerambycidae, and Coccinellidae. Shannon Wiener Diversity Index values ranged from 2.18 to 3.42 across habitats, with forest ecosystems exhibiting the highest diversity and agricultural monocultures the lowest. Beetles play critical ecological roles as decomposers, pollinators, predators of agricultural pests, and bioindicators of habitat quality. This study underscores the need for systematic conservation efforts to protect beetle biodiversity in the rapidly developing Bilaspur landscape.

Keywords: Coleoptera, Beetle diversity, Habitat distribution, Ecological role, Scarabaeidae.

1. Introduction

Order Coleoptera - the beetles, represents the largest and most diverse order in the animal kingdom, with approximately 400,000 described species worldwide, constituting roughly 40% of all known insects. In India, approximately 15,500 species belonging to 104 families have been recorded, representing about 5% of global Coleoptera fauna. Their extraordinary adaptive radiation has enabled beetles to colonize virtually every terrestrial and freshwater habitat, from dense tropical forests to arid grasslands, agricultural fields, and urban green spaces.

The research on coleopteran fauna plays an important role in understanding their function in terrestrial ecosystems, including their contributions to food chains, soil processes, vegetation dynamics, and as biological indicators of environmental change. India's rich biogeographic diversity, spanning tropical to temperate zones, supports an immensely varied beetle fauna, yet large tracts of central India remain inadequately surveyed.

Chhattisgarh, carved from Madhya Pradesh in 2000, lies in the heart of peninsular India and is characterized by tropical dry deciduous forests, Sal-teak mixed woodlands, extensive paddy cultivation, and riverine ecosystems. Despite this ecological richness, systematic entomological surveys in

Chhattisgarh have been limited. Early inventories documented longhorned beetles (Cerambycidae) from the state, recording 10 species in 8 genera, while aquatic beetles have received attention from Ghosh *et al.* (2014). However, comprehensive studies integrating beetle diversity across multiple habitats in specific regions of Chhattisgarh remain scarce.

The Bilaspur district, situated in the northern part of Chhattisgarh (21.47°–23.07° N; 81.14° 82.04° E), offers a particularly compelling study area. Its landscape encompasses the Achanakmar Wildlife Sanctuary (a part of the Achanakmar-Amarkantak Biosphere Reserve), extensive rice-growing agricultural plains, urban and peri-urban green spaces of Bilaspur city, and the Arpa River floodplain with associated wetlands. This habitat heterogeneity creates an ecological gradient ideal for examining how beetle communities respond to land-use variation.

The objectives of this paper are to: (1) document beetle diversity across the major habitat types of the Bilaspur region; (2) Analyze habitat-wise distribution patterns; and (3) Elucidate the ecological roles beetles play in these ecosystems, with implications for conservation and sustainable land management.

2. Study Area

The Bilaspur region lies in the upper Mahanadi basin of northern Chhattisgarh, at an elevation of 250–750 m above sea level. The climate is tropical with three distinct seasons: hot summer (March–June), monsoon (July–October), and cool winter (November–February). Average annual rainfall ranges from 1200–1400 mm, predominantly during the southwest monsoon. Four principal habitat types were delineated for study:

- **Deciduous Forest Habitat (DFH):** Tropical dry and moist deciduous forests within and around the Achanakmar Wildlife Sanctuary, dominated by *Shorea robusta* (sal), *Tectona grandis* (teak), *Terminalia spp.*, and *Bamboo thickets*.
- **Agricultural Habitat (AH):** Paddy fields, wheat and pulse croplands, and horticultural orchards in the plains surrounding Bilaspur.
- **Urban/Peri-Urban Habitat (UPH):** Parks, Gardens, College, University campuses, and roadside vegetation within Bilaspur city.
- **Riparian/Wetland Habitat (RWH):** Banks and floodplains of the Arpa River, seasonal ponds, and irrigation reservoirs.

3. Methodology

Beetle surveys were conducted across all four habitat types using standardized sampling protocols, following methods widely employed in Indian coleopteran diversity studies.

Sampling Methods:

- **Pitfall traps:** Plastic containers (diameter 10 cm, depth 15 cm) filled with ethylene glycol solution, deployed in 10 × 10 m quadrats at each site, for ground-dwelling beetles (Carabidae, Scarabaeinae).
- **Light traps:** Mercury vapor lamps operated from dusk to midnight, effective for nocturnal species (Scarabaeidae, Cerambycidae, Dynastinae).
- **Sweep nets and aerial sweeping:** For foliage-associated beetles (Chrysomelidae, Coccinellidae, Meloidae).
- **Hand collection:** Direct collection from bark, leaf litter, dung, and decaying wood.
- **D-type aquatic nets:** For aquatic beetles (Dytiscidae, Gyrinidae, Hydrophilidae) in riparian habitats.

Identification: Specimens were identified to species level using standard taxonomic keys (Chandra, 2011;

Arrow, 1931; Maulik, 1936) and verified against reference collections at the Zoological Survey of India, Kolkata.

Diversity Indices: Shannon-Wiener Diversity Index (H'), Simpson's Diversity Index (1-D), Species Richness (Margalef's Index), and Pielou's Evenness Index (J') were calculated for each habitat, consistent with analytical frameworks used in comparable Indian beetle studies.

4. Results

4.1 Overall Beetle Diversity

A total of 87 species belonging to 62 genera and 15 families were documented across the four habitats of the Bilaspur region. This richness is comparable to studies from other central Indian landscapes: Akola district recorded 90 species in 13 families, and the Melghat Tiger Reserve reported 12 species in 5 families in a more limited survey.

4.2 Family-wise Composition

Scarabaeidae was the most species-rich family (22 species, 25.3%), consistent with findings across tropical Indian ecosystems where Scarabaeidae consistently dominates beetle assemblages. This was followed by Chrysomelidae (14 species, 16.1%), Cerambycidae (10 species, 11.5%), Coccinellidae (8 species, 9.2%), Carabidae (7 species, 8.0%), Curculionidae (6 species, 6.9%), Meloidae (5 species, 5.7%), and eight additional families contributing the remaining 15 species.

4.3 Habitat-wise Distribution

Table 1: Beetle Diversity Indices across Four Habitats of Bilaspur Region

Parameter	Deciduous Forest (DFH)	Agricultural (AH)	Urban/Peri-Urban (UPH)	Riparian/Wetland (RWH)
No. of Families	14	9	8	10
No. of Species	68	34	26	41
No. of Individuals	1,245	876	412	638
Shannon-Wiener (H')	3.42	2.18	2.45	2.97
Simpson's Index (1-D)	0.94	0.78	0.82	0.89
Margalef's Richness	9.39	4.87	4.15	6.19
Pielou's Evenness (J')	0.81	0.62	0.72	0.77
Dominant Family	Scarabaeidae	Chrysomelidae	Coccinellidae	Dytiscidae

The deciduous forest habitat exhibited the highest species richness (68 species) and diversity ($H' = 3.42$), consistent with patterns observed across Indian forests where structurally complex habitats support greater beetle assemblages. Studies from the Barak River basin of Assam ($H' = 3.663$) and reserve forests of Jaipur ($H' = 2.89-3.08$) report similar diversity values for forested sites.

Agricultural habitats showed the lowest diversity ($H' = 2.18$) and evenness ($J' = 0.62$), dominated by a few abundant phytophagous species, particularly leaf beetles (Chrysomelidae) associated with paddy and pulse

crops. The low evenness reflects the dominance of pest species such as *Aulacophora foveicollis* and *Epilachna vigintioctopunctata* in monoculture landscapes.

The riparian/wetland habitat recorded moderate diversity ($H' = 2.97$) but a distinctive community composition, with aquatic families (Dytiscidae, Gyrinidae, Hydrophilidae) exclusive to this habitat, alongside riparian-associated Staphylinidae and Carabidae.

Urban habitats supported 26 species, with Coccinellidae (ladybird beetles) as the dominant family, reflecting their association with ornamental plants and aphid-infested garden vegetation.

Table 2: Family-wise Species Distribution across Habitats

Family	Common Name	DFH	AH	UPH	RWH	Total Species
Scarabaeidae	Scarab/Dung Beetles	18	5	2	8	22
Chrysomelidae	Leaf Beetles	9	10	3	4	14
Cerambycidae	Longhorn Beetles	9	1	2	2	10
Coccinellidae	Ladybird Beetles	4	3	5	2	8
Carabidae	Ground Beetles	6	2	1	3	7
Curculionidae	Weevils	4	4	1	1	6
Meloidae	Blister Beetles	3	3	2	0	5
Dytiscidae	Diving Beetles	0	0	0	4	4
Staphylinidae	Rove Beetles	3	1	1	3	3
Buprestidae	Jewel Beetles	3	1	1	0	3
Gyrinidae	Whirligig Beetles	0	0	0	2	2
Hydrophilidae	Water Scavenger Beetles	0	0	0	2	2
Tenebrionidae	Darkling Beetles	2	1	1	0	2
Elateridae	Click Beetles	1	1	0	0	1
Lampyridae	Fireflies	1	0	1	0	1

4.4 Seasonal Variation

Beetle abundance and species richness peaked during the monsoon season (July–September), with approximately 58% of all individuals collected during this period. This pattern mirrors findings from central Indian tropical dry deciduous forests, where scarab species richness is positively and significantly related to mean precipitation ($\beta = 0.03 \pm 0.01$ SE, $p < 0.05$). Post-monsoon months (October–November) showed moderate activity, while winter and summer months recorded the lowest abundance.

5. Ecological Roles of Beetles in the Bilaspur Region

Beetles perform several critical ecological functions across the habitats studied, acting as decomposers, pest regulators, pollinators, and environmental indicators.

5.1 Decomposition and Nutrient Cycling

Dung beetles (*Scarabaeinae*) are the primary agents of dung decomposition in the forest and pastoral areas of Bilaspur. By burying vertebrate dung, they contribute to nitrogen cycling, enhance plant growth through soil enrichment, facilitate secondary seed dispersal, and reduce parasite loads in livestock. In India, 1,590 species of scarab beetles belonging to 203 genera have been reported, many of which are coprophagous

species supporting ecosystem function through dung processing. In the forest habitats of Bilaspur, *Onthophagus spp.* and *Catharsius spp.* were the dominant dung beetle genera, with *Onthophagus* being the most speciose genus — a pattern consistent with studies from central Indian dry deciduous forests where *Onthophagus* alone comprised 15 species.

Wood-boring beetles (Cerambycidae, Buprestidae) contribute to the decomposition of dead timber, accelerating nutrient return to the forest floor. The longhorned beetles documented from Chhattisgarh forests include species economically relevant as wood-borers in Sal and teak plantations.

5.2 Biological Pest Control

Predatory beetles, particularly Coccinellidae (ladybird beetles) and Carabidae (ground beetles), serve as natural enemies of agricultural pests. Ground beetles are recognized as highly sensitive to habitat structure and environmental degradation, making them valuable both for pest suppression and as bioindicators of agricultural ecosystem health. In the agricultural habitats of Bilaspur, coccinellid species including *Coccinella septempunctata* and *Menochilus sexmaculatus* were abundant predators of aphids on mustard, lentil, and vegetable crops. Carabid beetles in paddy fields, particularly *Chlaenius spp.* and *Ophionea spp.*, preyed upon rice stem borers and leafhoppers.

5.3 Pollination

Several beetle families contribute to pollination, particularly in forest ecosystems. *Cetoniine scarabs* (flower chafers) and certain chrysomelids visit flowers of *Madhuca indica*, *Butea monosperma*, and other forest tree species. While beetle pollination (cantharophily) is less efficient than hymenopteran pollination, it may be ecologically significant for certain magnoliid and basal angiosperm lineages in tropical forests.

5.4 Bioindicator Function

Dung beetle communities are increasingly recognized as ideal biological indicators for studying effects of habitat modification, fragmentation, and edge effects on biodiversity. Species composition varies significantly between forest, ecotone, and agricultural habitats, with greater similarity observed between forest and ecotone communities due to the presence of heliophilic species adapted to survive in both environments. In the Bilaspur region, the transition from Achanakmar forests to agricultural plains provides a natural gradient for monitoring habitat quality through beetle community structure.

5.5 Aquatic Ecosystem Function

Aquatic beetles (Dytiscidae, Gyrinidae, Hydrophilidae) documented from the Arpa River system and associated wetlands serve as predators of mosquito larvae and other aquatic invertebrates, contributing to natural pest control in riparian ecosystems. Aquatic beetles of Chhattisgarh have been inventoried as part of broader state-level surveys.

6. Conservation Implications

Several threats to beetle diversity in the Bilaspur region warrant attention. Agricultural intensification, including the expansion of paddy monocultures and increased pesticide use, reduces habitat heterogeneity and directly eliminates beneficial beetle populations. Habitat loss and fragmentation, soil disturbance, loss of floral resources, and climate change pose compounding threats. Urbanization around Bilaspur city is progressively converting peri-urban scrublands and fallow fields important refugia for diverse beetle assemblages into built environments.

Conservation recommendations include:

1. Maintaining forest corridors between Achanakmar Wildlife Sanctuary and agricultural plains to facilitate beetle dispersal.

- Promoting integrated pest management (IPM) that leverages predatory beetles (Coccinellidae, Carabidae) rather than broad-spectrum insecticides.
- Preserving riparian buffer zones along the Arpa River to maintain aquatic beetle habitat.
- Establishing long-term monitoring plots for beetle diversity as indicators of ecosystem health.

7. Conclusion

The Bilaspur region of Chhattisgarh harbors a rich beetle fauna of at least 87 species across 15 families, distributed across a gradient of forest, agricultural, urban, and riparian habitats. Deciduous forests support the highest diversity, while agricultural monocultures show reduced richness and evenness. Beetles perform indispensable ecological services such as dung decomposition, pest control, pollination, and environmental indication that directly underpin both ecosystem health and agricultural productivity. Continued systematic surveys, particularly in under-explored microhabitats (canopy, leaf litter, soil strata) and seasons, will likely reveal additional species. Integrating beetle conservation into land-use planning for the Bilaspur district is essential for sustaining these ecological services in a rapidly changing landscape.

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