



## Diversity, seasonal distribution and community structure of insect fauna in Udanti-Sitanadi Wildlife Sanctuary, Chhattisgarh, India

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### Abstract

The present study provides a comprehensive inventory and analysis of the insect fauna of Udanti-Sitanadi Wildlife Sanctuary, Chhattisgarh, India. A total of 68,420 individuals representing 68 species, 38 families, and 11 orders were recorded. Among the orders, Blattodea was the most abundant (38,450 individuals), followed by Diptera (16,730), Hymenoptera (6,760), and Lepidoptera (5,030). Lepidoptera exhibited the highest taxonomic diversity with eight families, 16 subfamilies, and 22 species, while Mantodea and Trombidiformes had the lowest representation. Seasonal analysis revealed significant variation in abundance, with Blattodea and Diptera peaking during the rainy season, whereas Lepidoptera showed progressive increases from winter to monsoon. The alpha diversity indices, including Shannon ( $H' = 4.52$ ), Simpson (0.074), and Margalef richness index (6.02), indicated a species-rich and moderately uneven community. Ecological classification showed herbivores (24 species) and pollinators (23 species) to be dominant, followed by predators, decomposers, parasites, and omnivores. These findings highlight the taxonomic richness, seasonal dynamics, and functional diversity of the insect community in the sanctuary, providing baseline data for future monitoring, conservation, and management of insect biodiversity in central India.

**Keywords:** Wildlife, sanctuary, diversity, taxonomy, ecology

### Introduction

Insects are the most diverse and abundant group of animals, playing vital roles in maintaining ecosystem functions through pollination, decomposition and pest regulation. Insect also play a vital role in nutrient cycling, like microorganism (Verma and Verma, 2017). India alone hosts over 63,000 known insect species, representing nearly 6% of global insect diversity (Prakhar *et al.*, 2021; SD *et al.*, 2021) [20]. Their adaptability to a wide range of habitats, life-history strategies, and dietary preferences makes them key indicators of ecosystem health (Mondal & Mondal, 2024; Prakhar *et al.*, 2021) [16, 20]. Despite their ecological significance, insect diversity is strongly influenced by seasonal changes, with variations in abundance and species composition directly affecting ecological processes such as plant reproduction and food availability for higher trophic levels (Arun & Vijayan, 2004; Saru *et al.*, 2023; Prakhar *et al.*, 2021) [1, 20].

Understanding the diversity, seasonal dynamics, and community structure of insects is therefore crucial for conservation planning, agricultural management, and ecosystem sustainability (Kumar *et al.*, 2023; Verma *et al.*, 2023) [26]. Accurate identification of species is essential, not only to advance entomological research but also to mitigate crop losses caused by pest species, highlighting the need for efficient taxonomic and non-expert identification methods given the vast number of undescribed insects worldwide (Kumar *et al.*, 2023; Martineau *et al.*, 2016) [15].

The Udanti-Sitanadi Wildlife Sanctuary in Chhattisgarh, India, encompasses a mosaic of dry and moist deciduous forests, grasslands, and riparian habitats, providing a unique landscape to study insect diversity (Das *et al.*, 2023; Mukherjee & Hossain, 2024) [7, 17]. Its transitional biogeographic location, diverse topography, and microclimatic gradients influence insect phenology, abundance, and community composition, making it an ideal

site for assessing temporal and spatial patterns in insect populations (Mahata *et al.*, 2023; Checa *et al.*, 2014) [14]. Seasonal variations, especially the alternation of wet and dry periods, further shape insect activity, with population peaks typically following the monsoon and reduced activity during dry seasons (Chakravarty & Mishra, 2014; Dijk *et al.*, 2024) [8].

While large mammals and birds of the Udanti-Sitanadi region are well-studied, the insect fauna remains poorly documented. Groups such as *Coleoptera*, *Hymenoptera*, and *Orthoptera* remain particularly underexplored. This highlights the need for comprehensive inventories and quantitative assessments to establish baseline data, monitor ecological changes, and identify key taxa that support ecosystem functioning (Singh *et al.*, 2024; Verma *et al.*, 2023) [24, 26].

Conservation of insect diversity in protected areas requires integrative approaches, including habitat preservation, restoration, and adaptive management. Protecting keystone and ecosystem-engineering insects such as ants, termites, dung beetles, and pollinators can significantly enhance ecosystem functionality by maintaining nutrient cycling, soil structure, and trophic interactions (Chowdhury *et al.*, 2022; Şen & Grillo, 2018) [4, 22]. Integrating ecological modelling, remote sensing, and local knowledge further supports targeted conservation strategies and long-term management of insect-mediated ecosystem services (Hakim *et al.*, 2025; Palma *et al.*, 2025).

Despite their importance, substantial gaps remain in understanding insect community structure, seasonal distribution, and functional roles, particularly in tropical forests and fragmented landscapes (Kumar *et al.*, 2023; Duffus *et al.*, 2023) [9]. Addressing these gaps is essential for developing evidence-based strategies that safeguard insect diversity and the ecological processes they sustain.

## Materials and methods

### Study Area

The study was carried out in Udanti (237 km<sup>2</sup>) and Sitanadi (556 km<sup>2</sup>) Wildlife Sanctuaries, located in Gariaband and Dhamtari districts of Chhattisgarh, India (Table 1). The sanctuaries feature dry and moist deciduous forests, grasslands, wetlands, riparian zones, and low hills (320–736 m above sea level). The region has a tropical climate with three main seasons: winter (November–February), summer (March–June), and monsoon (July–October). Annual rainfall ranges from 1,200 to 1,600 mm, and temperatures vary from 8°C in winter to over 44°C in summer. These variations, along with differences in vegetation and microhabitats, strongly affect insect distribution and activity. Climatic data during the study were collected from the nearest meteorological station.

### Sampling

Insects were sampled across different habitat types, including sal forests, grasslands, and riparian areas, to cover habitat diversity. Sampling sites were selected to represent variations in vegetation, microclimate, and elevation. Transects and quadrats were established to sample insects from the ground, vegetation, air, and aquatic habitats. Monthly sampling over one year allowed us to capture seasonal changes in insect communities (Figure 1).

Multiple methods were used to collect insects from different habitats and functional groups

- Sweep nets were used in the morning and late afternoon to collect insects from plants.
- Light traps captured nocturnal insects such as moths and beetles.
- Pitfall traps collected ground-active insects like ants and beetles.
- Aquatic nets were used in streams and wetlands for aquatic insects, including dragonflies and their larvae.
- Hand collection and visual surveys helped find rare or cryptic species.

### Identification and Data Analysis

Specimens were identified using standard keys and reference books (Choudhury, 2006; Rathore, 2009) [21], and identifications were confirmed with experts and museum collections when needed.

Insect diversity was measured at family, subfamily, and species levels. Relative abundance, species richness, and evenness were calculated, and Shannon-Wiener and Simpson's indices were used to compare diversity across habitats and seasons. Insects were also grouped by ecological roles such as pollinators, decomposers, or herbivores to understand their contribution to ecosystem functions.

## Results

The insect fauna of Udanti and Sitanadi Wildlife Sanctuary was distributed across 11 orders encompassing 38 families, with a total recorded abundance of 68,420 individuals (Table 2). Among these, *Blattodea* exhibited the highest abundance with 38,450 individuals, followed by *Diptera* (16,730), *Hymenoptera* (6,760), and *Lepidoptera* (5,030). In contrast, *Mantodea* (95 individuals) and *Araneae* (350 individuals) were the least abundant orders. Taxonomic analysis revealed that *Lepidoptera* was the most diverse order, comprising 8 families (21.05% of total families), 16 subfamilies (32.65%), and 22 species (32.35%) (Table 3; Figure 2). *Diptera* and *Hemiptera* contributed equally at the family level (13.16% each), whereas orders *Mantodea* and *Trombidiformes* had the lowest taxonomic representation. The insect community consisted of 68 species across 38 families and 53 subfamilies

Seasonal analysis indicated that insect abundance fluctuated across winter, summer, and rainy seasons (Table 4; Figure 3). *Blattodea* showed peak abundance during the rainy season (15,420 individuals), while *Diptera* also recorded a higher abundance in the monsoon (6,590). *Lepidoptera* abundance increased progressively from winter (1,315) to rainy season (2,048), suggesting seasonal breeding or activity patterns. Detailed species-level inventory (Tables 5 and 6) identified characteristic representative species for each order. For instance, *Lepidoptera* included *Danaus chrysippus*, *Papilio polytes*, and *Attacus atlas*, while *Diptera* comprised vector species such as *Aedes aegypti* and *Anopheles stephensi*. Seasonal abundance classes highlighted temporal dynamics, with many *Lepidoptera* species ranging from occasional in winter to dominant in the monsoon. *Hymenopterans* such as *Apis dorsata* and ants exhibited widespread occurrence across all seasons.

The insect community was characterized by high diversity, as reflected in alpha diversity indices (Table 7). A total of 68 species were identified with an average population size of 1,010 individuals per species. The Shannon diversity index ( $H' = 4.52$ ) and Margalef richness index (6.02) indicated high species richness, whereas the Simpson index (0.074) and Dominance index (0.926) suggested dominance by a few taxa, particularly *Blattodea* and *Diptera*. Equitability (0.743) and Gini coefficient (0.726) confirmed a moderately uneven distribution among species. Classification of insects by ecological role (Table 8) showed that herbivores (24 species) and pollinators (23 species) formed the majority of the community. Predators and decomposers were represented by 7 species each, whereas parasites or disease vectors comprised 4 species. A minor fraction (3 species) displayed mixed ecological functions, including omnivory or predatory-pollination. This highlights the functional diversity and ecological complexity of the insect assemblage in the sanctuary.

**Table 1:** Geographical, climatic and ecological characteristics of Udanti–Sitanadi Wildlife Sanctuary, Chhattisgarh, India

Parameter	Udanti Wildlife Sanctuary	Sitanadi Wildlife Sanctuary
Location	Gariaband district, Chhattisgarh, India	Dhamtari district, Chhattisgarh, India
Area	Approximately 240 km <sup>2</sup>	Approximately 556 km <sup>2</sup>
Year established	1983	1974
Latitude	20°58'N to 21°08'N	20°45'N to 21°10'N
Longitude	82°14'E to 82°30'E	81°50'E to 82°20'E
Elevation range	320 to 370 meters	327 to 736 meters
Topography	Gently undulating terrain, plains, low hills	Undulating terrain with hills and valleys
Major rivers	Udanti River	Sitanadi River (tributary of Mahanadi River)
Forest type	Tropical dry deciduous forest	

Dominant tree species	Shorea robusta (Sal), Tectona grandis (Teak)
Climate	Tropical with distinct wet (Jun–Sep) and dry seasons
Average temperature (°C)	Maximum 32.9, Minimum 19.5
Total annual rainfall (mm)	1136.3
Relative humidity (%)	I 93%, II 79%
Average wind velocity (kmph)	2.1
Total evaporation (mm)	1308.3
Average sunshine (hours/day)	6.4
Months	Hottest: April (38.0 °C), Coldest: January (11.0–12.5 °C), Wettest: September (395.4 mm)

**Table 2:** Order-wise distribution, family composition and total abundance of insects recorded from Udanti–Sitanadi Wildlife Sanctuary

S. No.	Order	Families	Abundance
1	Lepidoptera	Nymphalidae, Papilionidae, Pieridae, Lycaenidae, Bombycidae, Noctuidae, Saturniidae, Uraniidae	5,030
2	Odonata	Libellulidae, Coenagrionidae	1,295
3	Coleoptera	Coccinellidae, Cerambycidae, Scarabaeidae, Tenebrionidae	1,130
4	Blattodea	Termitidae, Rhinotermitidae, Blattidae, Ectobiidae	38,450
5	Hymenoptera	Formicidae, Apidae, Megachilidae, Vespidae	6,760
6	Diptera	Culicidae, Muscidae, Tabanidae, Drosophilidae, Syrphidae	16,730
7	Hemiptera	Cicadellidae, Pentatomidae, Rhopalidae, Diaspididae, Aphididae	3,860
8	Orthoptera	Gryllidae, Acrididae	1,650
9	Mantodea	Mantidae	95
10	Trombidiformes	Tetranychidae	2,300
11	Araneae	Pholcidae, Araneidae	350

**Table 3:** Taxonomic composition and relative contribution of insect and arachnid orders at family, subfamily and species levels

S. No.	Order	Family	Family Contribution	Subfamily	Subfamily Contribution	Species	Species Contribution
1	Lepidoptera	8	21.05%	16	32.65%	22	32.35%
2	Odonata	2	5.26%	2	4.08%	4	5.88%
3	Coleoptera	4	10.53%	5	10.20%	8	11.76%
4	Blattodea	4	10.53%	5	10.20%	5	7.35%
5	Hymenoptera	4	10.53%	7	14.29%	8	11.76%
6	Diptera	5	13.16%	5	10.20%	7	10.29%
7	Hemiptera	5	13.16%	4	8.16%	5	7.35%
8	Orthoptera	2	5.26%	2	4.08%	5	7.35%
9	Mantodea	1	2.63%	1	2.04%	1	1.47%
10	Trombidiformes	1	2.63%	1	2.04%	1	1.47%
11	Araneae	2	5.26%	1	2.04%	2	2.94%
Total	-	38	100.00%	53	100.00%	68	100.00%

**Table 4:** Season-wise species richness and abundance of insect orders in Udanti–Sitanadi Wildlife Sanctuary

S. No.	Order	Species Richness	Winter	Summer	Rainy	Total Abundance
1	Lepidoptera	22	1,315	1,582	2,048	4,945
2	Odonata	4	345	445	505	1,295
3	Coleoptera	8	305	330	400	1,035
4	Blattodea	5	5,960	7,870	15,420	29,250
5	Hymenoptera	8	1,875	2,265	2,620	6,760
6	Diptera	7	3,890	5,250	6,590	15,730
7	Hemiptera	5	980	1,220	1,660	3,860
8	Orthoptera	5	420	545	685	1,650
9	Mantodea	1	25	30	40	95
10	Trombidiformes	1	600	700	1,000	2,300
11	Araneae	2	100	115	135	350

**Table 5:** Order-wise taxonomic inventory of insect species recorded from the study area

Order	Family	Species
Lepidoptera	Nymphalidae, Papilionidae, Pieridae, Lycaenidae, Bombycidae, Noctuidae, Saturniidae, Uraniidae	<i>Danaus chrysippus</i> , <i>Junonia lemonias</i> , <i>Euploea core</i> , <i>Tirumala limniace</i> , <i>Parthenos sylvia</i> , <i>Hypolimnas misippus</i> , <i>Acraea violae</i> , <i>Lethe Europa</i> , <i>Idea leuconoe</i> , <i>Papilio polytes</i> , <i>Papilio demoleus</i> , <i>Graphium Agamemnon</i> , <i>Catopsilia Pomona</i> , <i>Pieris brassicae</i> , <i>Eurema hecabe</i> , <i>Pyrisitia nise</i> , <i>Zizina Otis</i> , <i>Arhopala centaurus</i> , <i>Bombyx mori</i> , <i>Spodoptera litura</i> , <i>Helicoverpa armigera</i> , <i>Attacus atlas</i> , <i>Lyssa zampa</i>
Odonata	Libellulidae, Coenagrionidae	<i>Orthetrum sabina</i> , <i>Neurothemis fulvia</i> , <i>Brachythemis contaminata</i> , <i>Agriocnemis pygmaea</i>
Coleoptera	Coccinellidae, Cerambycidae, Scarabaeidae, Tenebrionidae	<i>Coccinella septempunctata</i> , <i>Harmonia axyridis</i> , <i>Chilomenes sexmaculata</i> , <i>Batocera rufomaculata</i> , <i>Oryctes rhinoceros</i> , <i>Xylotrupes gideon</i> , <i>Scarabaeus sacer</i> , <i>Tenebrio molitor</i>
Blattodea	Termitidae, Rhinotermitidae,	<i>Odontotermes obesus</i> , <i>Microtermes obesi</i> , <i>Coptotermes heimi</i> , <i>Periplaneta americana</i> ,

	Blattidae, Ectobiidae	<i>Blattella germanica</i>
Hymenoptera	Formicidae, Apidae, Megachilidae, Vespidae	<i>Camponotus compressus, Solenopsis invicta, Apis dorsata, Apis cerana indica, Trigona iridipennis, Megachile lanata, Vespa tropica, Polistes olivaceus</i>
Diptera	Culicidae, Muscidae, Tabanidae, Drosophilidae, Syrphidae	<i>Aedes aegypti, Anopheles stephensi, Culex quinquefasciatus, Musca domestica, Tabanus striatus, Drosophila melanogaster, Eristalinus arvorum</i>
Hemiptera	Cicadellidae, Pentatomidae, Rhopalidae, Diaspididae, Aphididae	<i>Cicadella viridis, Nezara viridula, Leptocoris tagalicus, Aspidiotus destructor, Aphis craccivora</i>
Orthoptera	Gryllidae, Acrididae	<i>Gryllus bimaculatus, Acheta domesticus, Oxya japonica, Acrida exaltata, Oxya japonica</i>
Mantodea	Mantidae	<i>Mantis religiosa</i>
Trombidiformes	Tetranychidae	<i>Tetranychus urticae</i>
Araneae	Pholcidae, Araneidae	<i>Pholcus phalangioides, Argiope pulchella</i>

**Table 6:** Seasonal abundance pattern of representative insect species based on abundance classes

Order / Group	Representative Species (Scientific Name)	Winter	Summer	Monsoon
Lepidoptera (Butterflies & Moths)	<i>Danaus chrysippus, Junonia lemonias, Euploea core, Catopsilia pomona, Papilio polytes, Papilio demoleus, Graphium agamemnon, Tirumala limniace, Zizina otis, Parthenos sylvia, Eurema hecabe, Acraea violae, Arhopala centaurus, Lethe europa, Idea leuconoe, Pyrisitia nise, Chilomenes sexmaculata, Spodoptera litura, Helicoverpa armigera, Pieris brassicae, Hypolimnas misippus</i>	O, O, O, O, R, O, R, R, R, R, F, R, F, R, R, R, O, O, O, F	C, C, C, F, F, F, F, O, O, O, O, O, O, O, O, O, O, O, O	F, F, F, C, C, C, C, C, C, C, C, C, C, C, C, C, C, C, C, O
Coleoptera (Beetles & Ladybirds)	<i>Coccinella septempunctata, Harmonia axyridis, Batocera rufomaculata, Oryctes rhinoceros, Xylotrupes gideon, Scarabaeus sacer, Tenebrio molitor</i>	F, F, R, R, R, R, C	F, F, F, C, F, C, F	C, C, R, O, R, O, O
Hymenoptera (Bees, Wasps, Ants)	<i>Camponotus compressus, Solenopsis invicta, Apis dorsata, Apis cerana indica, Trigona iridipennis, Vespa tropica, Polistes olivaceus, Megachile lanata</i>	F, O, R, F, F, R, R, R	C, C, C, C, F, C, C, O	C, F, C, C, C, O, O, C
Diptera (Flies & Mosquitoes)	<i>Aedes aegypti, Anopheles stephensi, Culex quinquefasciatus, Musca domestica, Tabanus striatus, Drosophila melanogaster, Eristalinus arvorum</i>	R, R, O, O, R, F, R	O, O, F, C, C, C, O	D, D, D, C, F, C, C
Odonata (Dragonflies & Damselflies)	<i>Orthetrum sabina, Neurothemis fulvia, Agriocnemis pygmaea, Brachythemis contaminata</i>	R, R, R, R	F, O, O, O	C, C, C, C
Isoptera (Termites)	<i>Odontotermes obesus, Microtermes obesi, Coptotermes heimi</i>	C, C, C	C, C, C	C, C, C
Orthoptera / Hemiptera / Mites / Others	<i>Oxya japonica, Mantis religiosa, Acheta domesticus, Leptocoris tagalicus, Aspidiotus destructor, Aphis craccivora, Tetranychus urticae, Bombyx mori, Pholcus phalangioides, Argiope pulchella</i>	O, O, O, R, C, C, C, F, F, F	C, F, C, C, O, F, F, O, O, O	F, F, O, O, O, F, O, O, O, O

Class I (1–20%) = R (Rare); Class II (21–40%) = O (Occasional); Class III (41–60%) = F (Frequent); Class IV (61–80%) = C (Common); Class V (81–100%) = D (Dominant)

**Table 7:** Summary of dataset characteristics and alpha diversity indices of the insect community

S. No.	Metric	Value
1	Number of organisms of the respective species counted in the study area	68,420
2	Number of species identified	68
3	Average population size	1,010
4	Number of families identified	38
5	Simpson Index	0.074
6	Dominance Index	0.926
7	Reciprocal Simpson Index	13.5
8	Shannon Index	4.52
9	Berger-Parker Dominance Index	0.149
10	Margalef Richness Index	6.02
11	Equitability Index	0.743
12	Gini Coefficient	0.726

**Table 8:** Insect species count by ecological role

S. No.	Ecological Role	Number of Species
1	Pollinators	23
2	Herbivores	24
3	Predators	7
4	Decomposers	7
5	Parasites / Vectors	4
6	Others (Omnivores / Predatory-Pollinators)	3



Fig 1: Sample collection

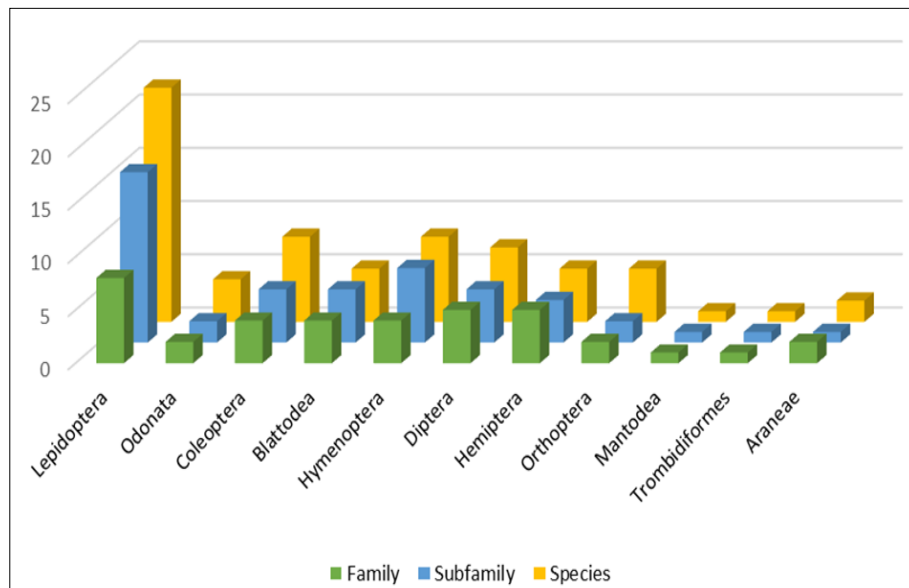


Fig 2: Taxonomic inventory of insect species recorded from the study area



*Hamatofera nodicornis*

*Terophylla camellifolia*

*Conehead Katydid*



Fig 3: Insects recorded from the study site

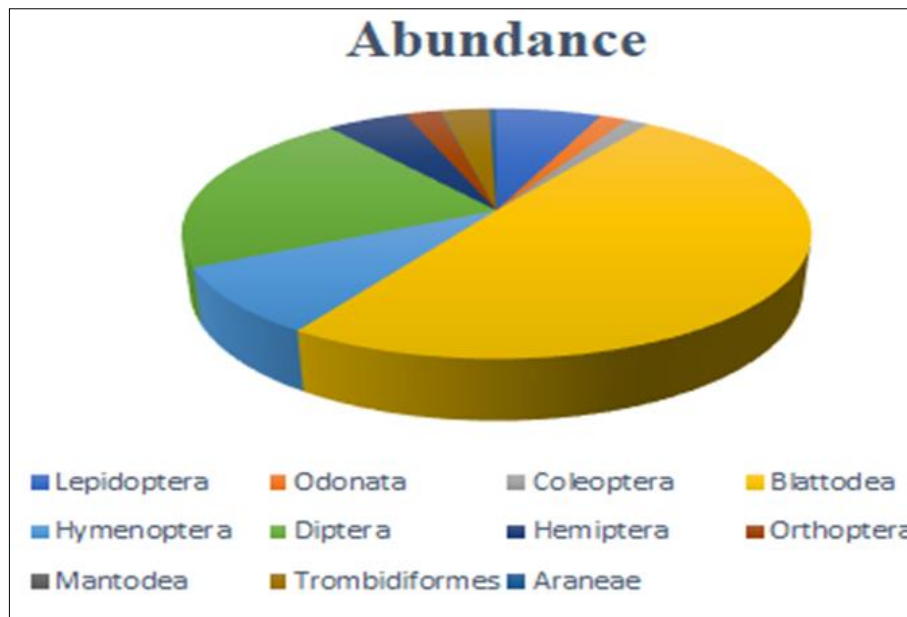


Fig 4: Total abundance across all orders

**Discussion**

The present study provides a comprehensive assessment of insect diversity, seasonal distribution, and community structure in the Udanti–Sitanadi Wildlife Sanctuary (USWS), Chhattisgarh, a region identified as ecologically heterogeneous but comparatively underexplored for entomofaunal diversity (Das *et al.*, 2023; Kothe *et al.*, 2023) [7]. The occurrence of 68 insect species belonging to 38 families and 11 orders highlights the sanctuary as an important repository of insect biodiversity within central India, supporting earlier observations that forested landscapes of Chhattisgarh harbour substantial but inadequately documented insect assemblages (Gupta & Chandra, 2016; Prakhar *et al.*, 2021) [10, 20].

The pronounced dominance of Blattodea in terms of abundance reflects the structural complexity and organic-rich forest floor conditions prevalent in USWS. The dry and moist deciduous forests, characterized by dense litter accumulation and decomposing plant material, provide ideal microhabitats for detritivorous insects (Parui *et al.*, 2015; Şen & Grillo, 2018) [18, 22]. Similar dominance of decomposer insects has been reported from central Indian forest ecosystems, where litter depth and soil organic matter strongly influence community composition (Martineau *et al.*, 2016; Winding *et al.*, 2020) [15, 28]. The high abundance of Diptera, particularly during the monsoon season,

corresponds with increased moisture, organic substrates, and microbial activity associated with seasonal rainfall (Vignesh *et al.*, 2020) [27]. Dipterans are known to respond rapidly to climatic fluctuations, especially rainfall and humidity, which regulate their breeding and survival (Chen *et al.*, 2014; Dijk *et al.*, 2024) [3, 8]. In contrast, Mantodea and Araneae showed low numerical abundance, a trend consistent with their predatory life strategies and higher trophic positions, as observed in other protected forest habitats (Martineau *et al.*, 2016; Mondal & Mondal, 2024) [15, 16].

Despite lower abundance, Lepidoptera emerged as the most taxonomically diverse order, contributing the highest number of families, subfamilies, and species. This pattern aligns with studies from central and peninsular India, where butterflies and moths exhibit high species richness due to strong dependence on host plant diversity and habitat heterogeneity (Mahata *et al.*, 2023; Singh *et al.*, 2024) [14, 24]. The dominance of sal-dominated and mixed deciduous vegetation in USWS provides a wide range of larval host plants and nectar resources, promoting lepidopteran diversification (Bhatt & Joshi, 2010; Jena & Narayanan, 2015) [2, 11].

The comparable family-level representation of Diptera and Hemiptera reflects their broad ecological amplitude and adaptability. Hemipterans are closely associated with plant

phenology and sap availability, while dipterans occupy multiple functional roles, including decomposers, pollinators, and vectors (Verma *et al.*, 2023; John *et al.*, 2024) [12, 26]. Similar patterns have been reported from other forest ecosystems in central India (Gupta & Chandra, 2016; Prakhar *et al.*, 2021) [10, 20].

Seasonal analysis revealed a clear increase in insect abundance during the monsoon, consistent with monsoon-driven productivity in tropical ecosystems (Rathore, 2009; Vignesh *et al.*, 2020) [21, 27]. Increased rainfall enhances vegetation growth and resource availability, which in turn stimulates insect emergence and reproduction (Chen *et al.*, 2014; Dijk *et al.*, 2024) [3, 8]. The progressive rise in Lepidoptera abundance from winter to monsoon reflects synchronization of life cycles with host plant availability, a phenomenon widely documented for butterfly assemblages in Indian forest ecosystems (Mahata *et al.*, 2023; Singh *et al.*, 2024) [14, 24].

Peak abundance of Blattodea and Diptera during the rainy season further emphasizes the importance of moisture and organic substrates in regulating decomposer and scavenger communities (Şen & Grillo, 2018; Winding *et al.*, 2020) [22, 28]. Reduced abundance during winter likely reflects lower temperatures and decreased biological activity, as reported for tropical insect communities (Shan *et al.*, 2024) [23].

The occurrence of representative species such as *Danaus chrysippus*, *Papilio polytes*, and *Attacus atlas* indicates relatively undisturbed habitat conditions and diverse vegetation structure within the sanctuary (Singh *et al.*, 2024) [24].

The presence of medically important dipterans, including *Aedes aegypti* and *Anopheles stephensi*, highlights the ecological complexity of insect communities in protected areas, where beneficial and vector species coexist.

Seasonal abundance categories revealed pronounced temporal shifts, with many species changing from rare or occasional during winter to common or dominant during the monsoon. In contrast, hymenopterans such as ants and *Apis dorsata* showed consistent year-round presence, underscoring their resilience and keystone role in ecosystem functioning (Cock *et al.*, 2012; Winding *et al.*, 2020) [5, 28]. The high Shannon diversity index ( $H' = 4.52$ ) and Margalef richness index (6.02) indicate a species-rich and structurally complex insect community, comparable to values reported from other protected areas in central India (Prakhar *et al.*, 2021; Mondal & Mondal, 2024) [16, 20]. However, the low Simpson index and high dominance value suggest numerical dominance by a few taxa, particularly Blattodea and Diptera. Such uneven abundance distributions are characteristic of tropical insect communities where generalist and detritivorous taxa exploit abundant resources (Martineau *et al.*, 2016; Ponge, 2021) [15, 19].

Functional classification showed dominance of herbivores and pollinators, reflecting strong linkage between insect diversity and vegetation structure in USWS. Pollinators play a critical role in forest regeneration and ecosystem stability (Verma *et al.*, 2023; John *et al.*, 2024) [12, 26]. The substantial presence of decomposers and detritivores highlights the importance of insects as ecosystem engineers involved in litter decomposition, nutrient cycling, and soil formation (Culliney, 2013; Şen & Grillo, 2018) [6, 22]. Compared to earlier studies from Chhattisgarh, which were often limited to specific insect groups or localized surveys, the present study provides a broader community-level perspective

(Gupta & Chandra, 2016; Prakhar *et al.*, 2021) [10, 20]. The findings reinforce the importance of Udanti–Sitanadi Wildlife Sanctuary as a significant refuge for insect diversity and emphasize the need to integrate insects into biodiversity monitoring and conservation planning within protected forest landscapes (Köthe *et al.*, 2023; Palma *et al.*, 2025) [13].

## Conclusion

The study demonstrates that Udanti–Sitanadi Wildlife Sanctuary hosts a highly diverse and abundant insect community spanning 11 orders and 38 families. Blattodea, Diptera, Hymenoptera, and Lepidoptera were the numerically dominant orders, while Lepidoptera showed the highest taxonomic diversity. Seasonal trends revealed that insect abundance and activity vary across winter, summer, and rainy seasons, with many taxa reaching peak populations during the monsoon. Diversity indices indicate a rich and moderately uneven community, reflecting the presence of dominant species alongside rarer taxa. Functional classification revealed that herbivores and pollinators constitute the majority of species, with a substantial representation of predators, decomposers, and vectors, indicating complex ecological interactions. This study provides a baseline inventory and ecological assessment of insect diversity in the sanctuary, emphasizing the need for continued monitoring and conservation to preserve the ecological integrity of this biologically significant landscape.

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