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Checklist of terrestrial entomofauna found in the west Garo hills district of Meghalaya, India

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Abstract
Insects are the most diverse group of organisms on Earth They play a vital role in the ecosystem by providing a range of crucial ecosystem services. this study aims to create a preliminary checklist of the insects found in the West Garo Hills district of Meghalaya. The district, covering an area of 3,714 km2, is located in the western part of Meghalaya (25˚45′ N; 90˚13′) and is a biodiversity hotspot nestled in the less explored regions of North East India. The study focused on five locations within the district: Dalu, Gambegre, Rongram, Selsella, and Jengjal. Regular site visits were conducted to record and identify the insects found, resulting in the identification of 95 species belonging to 7 orders. The Lepidoptera order had the highest number of species (29), followed by Coleoptera (14), Hemiptera (11), Diptera (11), and 10 species each of Orthoptera, Hymenoptera, and Odonata.

Keywords: Biodiversity, Ecosystem, Garo hills, Insect, Urbanization

Introduction
Insects are the most diverse group of organisms on the planet. Their role in ecosystems is indispensable, as they provide a multitude of essential services that help maintain the equilibrium of ecological processes. (Prather *et al*., 2013) [31]. The services include but are not limited to seed dispersal, pollination, organic matter processing, nutrient cycling and water filtration (Crespo-Pérez *et al*., 2020) [10]. According to available data there are around 5.5 million species of insects on Earth (Stork, 2018) [37]. However, this figure is likely an underestimate, as many species remain uncharacterized and undiscovered. Despite their critical ecological roles, insects are increasingly threatened by a range of factors. Numerous scientific studies highlight a troubling decline in insect diversity across various continents, although the rates of decline vary significantly by region. According to the International Union for Conservation of Nature (IUCN), less than 1% of described invertebrate species have been assessed for their conservation status. Nevertheless, nearly 40% of these assessed species are considered to be at risk of extinction (Dirzo *et al*., 2014) [11, 12]. in India, studies have reported reductions in insect diversity in different parts of the country, reflecting broader global trends (Gurule & Nikam, 2011) [16, 17]. The primary threats to insect diversity include land-use changes, such as deforestation and urban expansion; pesticide use, which can be harmful to both targeted pests and non-target species; environmental pollutants; invasive species, which can disrupt local ecosystems; and climate change, which alters habitats and affects the life cycles of many insect species (Basset and Lamarre, 2019) [3]. evidences of decline in insect biodiversity are mounting globally (Eisenhauer, 2019) [13]. Changes in insect diversity and abundance can profoundly affect numerous ecosystem functions and services, including primary productivity, which is the rate at which plants produce biomass; pollination, which is vital for the reproduction of many plants; and pest control, which helps manage populations of harmful organisms. Insects are also valuable indicators of environmental health and the impacts of urbanization. They respond sensitively to changes in habitat extent, quality, and management practices, making them crucial for monitoring and assessing the effects of urban development on biodiversity (Clark *et al*., 2008; Jaganmohan *et al*., 2012) [19, 20]. meghalaya is a state located in the North-East of India. It is bordered by Assam in the north and Bangladesh in the south. Approximately one-third of the state is covered by forest, and it falls within the Meghalaya subtropical forests ecoregion. This ecoregion is characterized by its mountain forests, which are distinct from the lowland tropical forests found to the north and south of the state. The forests of Meghalaya are home to a diverse range of plants, invertebrates, reptiles, mammals, and avifauna, making them ecologically significant. west Garo Hills, one of the largest districts in Meghalaya, is situated in the western part of the state. It is located approximately between the latitudes 90°30' and 89°40' E and longitudes 26° and 25°20' N. The Tura range, a major mountain range in this region, includes Nokrek National Park, which is situated just 2 kilometres from Tura Peak. This area, known for its unique biodiversity and ecological significance, provides a valuable context for studying insect diversity and the impacts of environmental changes in this region.

Material and methods
Study area
The study was carried out in the West Garo Hills district of Meghalaya (25˚45´N, 90˚13´E). The district occupies an area of 3,714 km^2 and has an average annual rainfall of 2729 mm, of which more than two-thirds occur during the monsoon while wintersare practically dry. For the study, five locations within the district were selected, Dalu, Gambegre, Rongram, Selsella and Jengjal. A Visual survey of was carried out from the month of from November 2022 to November 2023randomly in between 9 am to 11 am in

sunny days and evening 4pm to 9 pm. Survey was carried out on water bodies, open field, open tract of land and forest areas etc. Specimens were photographed with the mobile phones and incase of difficulties the specimens was captured by using insect net, photographed and released.

Data collection and identification

The research was conducted in five different locations within the West Garo Hills district of Meghalaya from November 2022 to November 2023. These locations were visited at regular intervals, and the observed insects were documented using photographic tools. The identified entomofauna was categorized using taxonomic keys (Shubhalaxmi, 2018; Sathe and Shinde, 2008) [33].

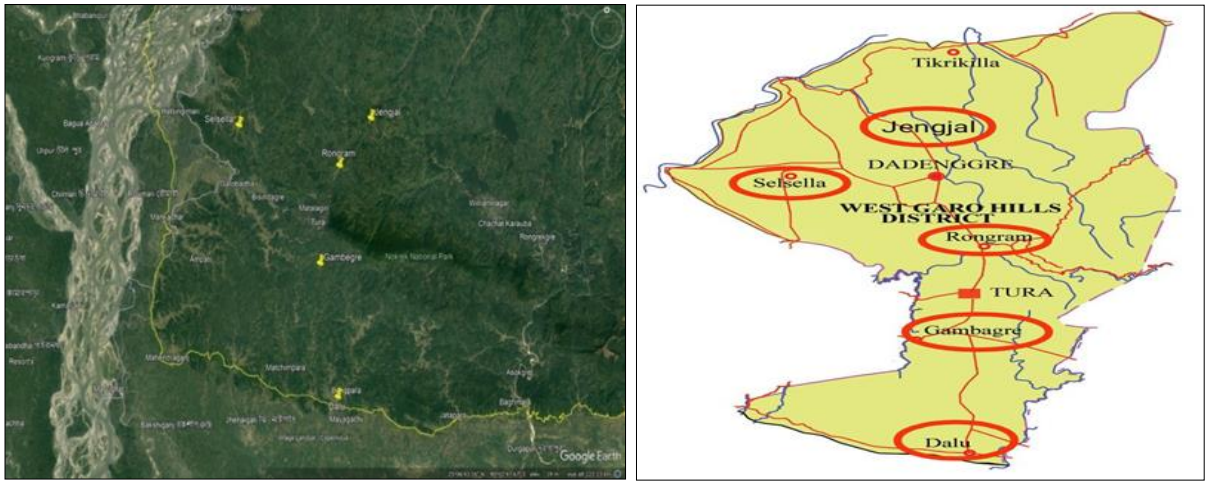


Fig 1: Satellite map of west Garo Hills showing the five locations selected for the study

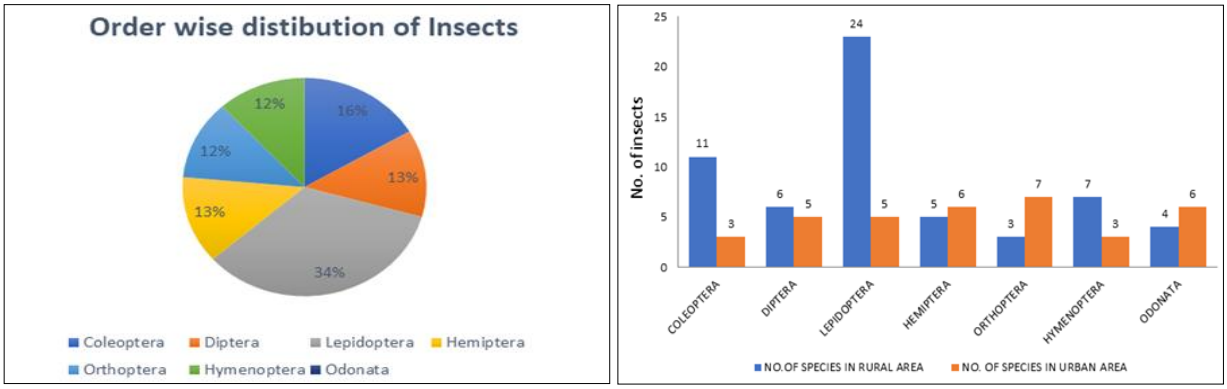
Results

In the one year of field survey 95 insect species were recorded from the area. These insects belong to different orders, the most dominant being Lepidoptera with 34 % of dominance followed by Coleoptera 16 %, Hemiptera and Diptera 13 % and Orthoptera, Hymenoptera and Odonata 12% each. Most of the species were found in the Dalu area which is a rural area of this region. Table 1 shows the list of all the insects found in the study area and Fig 1(a) shows the order wise dominance percentage of each order. Fig 1(b) shows comparison in the distribution of insects among the rural and urban regions of the study area.

Table 1: List of insects recorded from different selected areas of the West Garo Hills district

SL No	Order	Common name	Scientific name	Author	Urban/ Rural	Place
1.	Coleoptera	Golden tortoise beetle	*Charidotella sexpunctata*	Fabricius, 1781	Rural	Dalu
2.		Immaculate lady beetle	*Cycloneda munda*	Say, 1835	Rural	Dalu
3.		Spotless lady beetle	*Cyclonedas anguinea*	Linnaeus, 1763	Rural	Dalu
4.		White Spotted Flea Beetle	*Monolepta signata*	Oliver, 1808	Rural	Dalu
5.		Cucurbit leaf beetle	*Aulacophora femoralis*	Motschulsky, 1857	Rural	Dalu
6.		Longhorn Beetle	*Acanthocinus griseus*	Fabricius, 1792	Rural	Dalu
7.		Root weevil	*Diaprepesabbre viatus*	Linnaeus, 1758	Rural	Dalu
8.		Harlequin asian lady beetle	*Harmonia axyridis*	Pallas, 1773	Rural	Dalu
9.		Flea beetle	*Phyllotreta striota*	Fabricius, 1801	Rural	Dalu
10.		Mexican bean beetle	*Epilachna varivestis*	Mulsant, 1850	Rural	Dalu
11.		Seven spotted Ladybug	*Coccinella septempunctata*	Linnaeus,1758	Rural	Dalu
12.		Jewel beetle	*Belionata prasina*	Thunberg, 1789	Urban	Gambegre
13.		Tortoise beetle	*Deloyala guttata*	Olivier, 1790	Urban	Selsella
14.		Dung bettle	*Scarabaeus ambiguus*	Boheman 1857	Urban	Jengjal
15.	Diptera	Flies	*Limnophora spp*	Robineau 1830	Rural	Dalu
16.		Stilt-legged flies	*Rainieria calceata*	Fallen, 1820	Rural	Dalu
17.		Common green bottle fly	*Lucilia sericata*	Meigen, 1826	Rural	Dalu
18.		Crane flies	*Nephrotoma spp*	Meigen, 1828	Rural	Dalu
19.		Hoverflies	*Helophilus*	Meigen, 1822	Rural	Dalu
20.		Cabbage fly	*Delia radicum*	Linnaeus, 1758	Rural	Dalu
21.		Corn feeding syrphid fly	*Toxomeruspolitus*	Say, 1823	Urban	Gambegre
22.		Oriental fruit fly	*Bactrocera dorsalis*	Hendel, 1912	Urban	Selsella
23.		Longlegged flies	*Condylostylus spp*	Bigot, 1859	Urban	Selsella
24.		Flesh flies	*Sarcophaga carnaria*	Linnaeus, 1758	Urban	Jengjal
25.		Stable fly	*Stomoxys calcitrans*	Linnaeus, 1758	Urban	Rongram
26.	Lepidoptera	Cabbage white butterfly	*Pieris rapae*	Linnaeus, 1758	Rural	Dalu
27.		The Common crow	*Euploea core*	Cramer, 1780	Rural	Dalu
28.		Little yellow	*Euremalisa*	Boisduval,1829	Rural	Dalu
29.		Western centaur oakblue	*Arhopala spp*	Boisduval, 1832	Rural	Dalu
30.		Yellow-banded semi-looper moth	*Anomis combinans*	Walker, 1858	Rural	Dalu

31.		Common grass-blue	*Zizinala bradus*	Godart, 1824	Rural	Dalu
32.		Common sailor	*Neptishylas*	Linnaeus, 1758	Rural	Dalu
33.		The Common pierot	*Castalius rosimon*	Fabricius, 1775	Rural	Dalu
34.		The Wedgling moth	*Galgula partita*	Guenée, 1852	Rural	Dalu
35.		Rose hooktip moth	*Oreta rosea*	Walker, 1855	Rural	Dalu
36.		Omnivorous looper	*Sabulodes sp.*	Guenée, 1857	Rural	Dalu
37.		Common Fourring	*Ypthima huebneri*	Kirby, 1871	Urban	Gambegre
38.		Unknown	*Barsine roseororatus*	Butler, 1877	Rural	Dalu
39.		Grey Pansy	*Junonia atlites*	Linnaeus, 1763	Rural	Dalu
40.		Smooth-eyed bushbrown	*Orsotriaena medus*	Fabricius, 1775	Rural	Dalu
41.		Noctuid Moth	*Eublemma amabilis*	Saalmuller 1891	Rural	Dalu
42.		The northern broken dash	*Wallengrenia egeremet*	Scudder, 1863	Rural	Dalu
43.		Common fungus moth	*Metalectra discalis*	Grote 1876	Rural	Dalu
44.		Yellow-tail	*Euproctis similis*	Füssli, 1775	Rural	Dalu
45.		The snowy urola moth	*Urola nivalis*	Drury, 1773	Rural	Dalu
46.		Diamondback moth	*Plutellaxylostella*	Linnaeus, 1758	Rural	Dalu
47.		Baphomet Moth	*Creatonotos gangis*	Linnaeus, 1763	Rural	Dalu
48.		Cotton Leafworm	*Spodoptera litura*	Fabricius, 1775	Rural	Dalu
49.		Lesser cream wave	*Scopula immutata*	Linnaeus, 1758	Urban	Gambegre
50.		Common palmfly	*Elymnias hypermnestra*	Linnaeus, 1763	Rural	Dalu
51.		Handmaiden moth	*Syntomoidesimaon*	Cramer, 1780	Rural	Dalu
52.		The Punchinello	*Zemerosflegyas*	Cramer, 1780	Urban	Gambegre
53.		Handmaiden moth	*Amata cyssea*	Stoll, 1782	Urban	Selsella
54.		Unknown	*Niphandafusca*	Bremer & Grey, 1853	Urban	Jengjal
55.	Hemiptera	Stilt bugs	*Berytidae sp.*	Fieber, 1851	Rural	Dalu
56.		The red cotton stainer	*Dysdercus cingulatus*	Fabricius, 1775	Rural	Dalu
57.		Rice ear bug	*Leptocoris aoratoria*	Fabricius, 1764	Rural	Dalu
58.		Treehopper	*Ceraon vitta*	Walker, 1851	Rural	Dalu
59.		Brown marmorated stink bug	*Halyomorpha halys*	Stål, 1855	Rural	Dalu
60.		Box bug	*Gonocerus acuteangulatus*	Goeze, 1778	Urban	Gambegre
61.		Leaf footed bug	*Leptoglossus*	Guérin-Méneville, 1831	Urban	Gambegre
62.		Slender rice-bug	*Cletus trigonus*	Thunberg, 1783	Urban	Rongram
63.		Stink bug	*Eysarcoris montivagus*	Distant, 1902	Urban	Jengjal
64.		Red and-black froghopper	*Cercopis vulnerata*	Rossi, 1807	Urban	Rongram
65.		European lantern fly	*Dictyophara europaea*	Linnaeus, 1767	Urban	Rongram
66.	Orthoptera	The common green grasshopper	*Omocestus viridulus*	Linnaeus, 1758	Rural	Dalu
67.		Short-winged green grasshopper	*Dichromorpha viridis*	Scudder, 1863	Rural	Dalu
68.		Tropical house cricket	*Gryllodes sigillatus*	Walker, 1869	Rural	Dalu
69.		Black-kneed conehead	*Conocephalus melaenus*	De Haan, 1843	Urban	Gambegre
70.		Western bush katydids	*Insara spp*	Walker, 1869	Urban	Gambegre
71.		Pallid-winged grasshopper	*Trimerotropis pallidipennis*	Burmeister, 1838	Urban	Selsella
72.		Gray bird Grasshopper	*Schistocerca nitens*	Thunberg, 1815	Urban	Gambegre
73.		Green-striped grasshopper	*Chortophaga viridifasciata*	De Geer, 1773	Urban	Selsella
74.		Pine cricket	*Xenogryllus marmoratus*	Haan, 1842	Urban	Jengjal
75.		Common Field grasshopper	*Chorthippus brunneus*	Thunberg, 1815	Urban	Jengjal
76.	Hymenoptera	Bi-coloured Arboreal ant	*Tetraponera rufonigra*	Jerdon, 1851	Rural	Dalu
77.		Weaver ant	*Oecophylla longinoda*	Latreille, 1802	Rural	Dalu
78.		Saint valentine ant	*Crematogaster scutellaris*	Olivier, 1792	Rural	Dalu
79.		Paper wasp	*Ropalidia marginata*	Le peletier 1836	Rural	Dalu
80.		Apple sawfly	*Hoplocampa testudinea*	Klug, 1816	Rural	Dalu,
81.		Giant honey bee	*Apis dorsata*	Fabricius, 1793	Rural	Dalu
82.		Tropical carpenter bee	*Xylocopa latipes*	Drury, 1773	Urban	Gambegre
83.		Coconut ant	*Tapinoma sessile*	Say, 1836	Urban	Gambegre
84.		Common paper wasp	*Polistes exclamans*	Viereck, 1906	Urban	Selsella
85.		Green Tree ant	*Oecophyllas maragdina*	Fabricius, 1775	Rural	Dalu
86.	Odonata	Green marsh hawk	*Orthetrum sabina*	Drury, 1770	Rural	Dalu
87.		Aurora bluetail	*Ischnura aurora*	Brauer, 1865	Rural	Dalu
88.		Fulvous forest skimmer	*Neurothemis fulvia*	Drury, 1773	Rural	Dalu
89.		Red damselfly	*Xanthocnemis zealandica*	McLachlan, 1873	Urban	Jengjal
90.		Blue-tailed damselfly	*Ischnura elegans*	Vander 1820	Urban	Jengjal
91.		Blue dasher	*Pachydiplax longipennis*	Burmeister, 1839	Urban	Jengjal
92.		Long-legged marsh glider	*Trithemis pallidinervis*	Kirby, 1889	Urban	Jengjal
93.		Scarlet skimmer	*Crocothemis servilia*	Drury, 1773	Urban	Jengjal
94.		Rambur's forktail	*Ischnura ramburii*	Selys, 1850	Urban	Jengjal
95.		Spangled skimmer	*Libellula cyanea*	Fabricius, 1775	Urban	Jengjal



a. **b.**

Fig 2: Graphical representation of no. of insects found in the study area
a. Pie diagram showing the distribution of different insect orders within the study area
b. Showing different orders of insects recorded from rural and urban areas within the study area

Discussion

The insect populations in West Garo Hills district of Meghalaya display remarkable diversity and are essential for the functioning of terrestrial ecosystems. These creatures are critical for nutrient cycling, decomposition, and pest control, making them a focal point of scientific research. The study indicates that environmental factors, such as temperature, humidity, and vegetation, greatly influence the abundance and diversity of insect populations. moreover, the rich vegetation in the survey area has led to an enriched diversity of hymenopterans, likely due to the availability of flowers triggering foraging behavior of bees and nesting activities. It was observed that species richness and abundance are decreased in highly urbanized regions. the current study is the first effort to comprehensively investigate the diversity and abundance of terrestrial insects in the rural and urban areas of the district. It sheds light on the impact of extensive urbanization and habitat destruction on insect communities, highlighting the urgent need to identify vulnerable species and the threats to their survival. the findings of this study provide a crucial baseline dataset for understanding the decline of terrestrial insects due to increasing urbanization and habitat destruction. Nonetheless, further research is necessary to explore how population and diversity interact with environmental factors by incorporating more parameters and abiotic factors into the investigation.

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