**Diversity and Ecological Significance of Vespidae**

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**Abstract**

A comprehensive survey was conducted to document the diversity of vespid wasps (Hymenoptera: Vespidae) using Moericke traps as the primary sampling method. The study, carried out in 2020, recorded a total of 19 species belonging to 12 genera and 4 subfamilies, highlighting the rich vespid fauna in the surveyed region. The findings contribute to the understanding of vespid diversity and distribution, emphasizing the efficacy of Moericke traps in capturing these insects. This research provides valuable baseline data for future ecological and conservation studies on Vespidae.

**Keywords:** Vespidae, wasp diversity, Moericke traps, species inventory, Hymenoptera,

**Introduction**

India is the fastest-growing and second-most populous country in the world, trailing only China (Koshy 2020). With its rapidly expanding population, India is projected to surpass China in the coming years (Gladstone 2015). This demographic surge has intensified the demand for natural resources, posing a significant challenge in balancing economic development with biodiversity conservation. Agriculture, a critical sector supporting India’s population, has also emerged as a major driver of global biodiversity loss (Somavilla et al. 2016).

Vespidae, a cosmopolitan family of predatory wasps, plays a crucial ecological and economic role in ecosystems. These wasps serve as pollinators, natural predators, and effective biocontrol agents, making them indispensable for sustainable agriculture (Das and Gupta 1989). Several vespid species have been successfully employed in agro-ecosystems worldwide to control pest populations, reducing reliance on chemical pesticides (Gould and Jeanne 1984; Picanço et al. 2010).

Despite their ecological significance, studies documenting the diversity and abundance of Vespidae in India remain limited. Baseline data on species composition and distribution are essential to assess the impact of anthropogenic activities on insect populations (Lawton et al. 1998). While some taxonomic studies on Indian Vespidae exist (Pannure et al. 2016), comprehensive surveys evaluating their diversity across different habitats are scarce. The present study was conducted to document and analyze the diversity of Vespidae, providing critical insights into their ecological roles and conservation needs in the face of rapid environmental changes.

**Methodology**

**Study Area and Sampling Design**

The study was conducted in 2020, with sampling carried out over 10 days each month, accumulating a total of 120 sampling days. Fifty Moericke traps were deployed at each study site. These traps consisted of yellow-colored plastic containers (20 × 8 cm) filled with a water-surfactant solution to reduce surface tension and enhance insect capture efficiency.

**Trap Maintenance and Specimen Collection**

* Traps were serviced every alternate day to prevent degradation of specimens.
* Collected specimens were sieved out, and traps were refilled with fresh surfactant solution.
* Wasps were preserved in 70% ethanol for further taxonomic analysis.

**Specimen Processing and Identification**

Specimens were either double-mounted or directly pinned for morphological examination.Identification was performed using Leica S8APO stereo zoom microscope and validated with taxonomic keys from:Das & Gupta (1989),Carpenter & Nguyen (2003),Kojima et al. (2007),Pannure et al. (2016), High-resolution imaging was conducted using a Nikon camera for documentation.

**Diversity and Statistical Analysis**

Species diversity was assessed using the following **ecological indices**:

1. **Simpson’s Diversity Index (SDI)**

D=Σn(n−1)/N(N−1)

SDI=1−D

\*(where n*n* = individuals of a species, N = total individuals; ranges 0–1, higher values = greater diversity)\*

1. **Shannon-Wiener Index (H’)**

H’=−Σ(Pi lnPi)

*(where Pi=relative abundance of species, i; =higher, H’ = greater diversity)*

1. **Margalef’s Richness Index (α)**

α=S−1/ lnN​

*(where S = total species, N = total individuals; measures species richness)*

1. **Pielou’s Evenness Index (E₁)**

E1=H’/lnS ​

*(where S = total species; assesses uniformity of species distribution)*

1. **Beta Diversity (Jaccard Index, JI)**

JI=j/ a+b−j​

*(where j = shared species between sites A & B; a,b  = species in each site; measures habitat dissimilarity)*

All statistical analyses were performed using **Microsoft Excel (2019)**.

**Results and discussion**

A total of 19 species, 12 genera and 4 subfamilies of Vespidae have been collected in yr 2020 (**table-1**). The 4 subfamilies are Eumeninae, Polistinae, Stenogastrinae and Vespinae recorded. The genera Antepipona de Saussure 1855, Delta de Saussure 1855, Phimenes Giordani Soika 1992, Rhynchium Spinola 1806, Xenorhynchium van der Vecht 1963, Polistes Latreille 1802, Ropalidia Guérin-Méneville 1831 and Vespa Linnaeus 1758 have been recorded. The heterogeneous environment of the forest with higher plant variety has a better number of niches to encourage the very best number of coexisting species (Latham and Ricklefs 1993, Braganca et al. 1998).total quantity of species richness is nineteen recorded at the side of total quantity of people are 125 .the Simpson’s Index of diversity is o.85 five calculated and Shannon Weiner Index is 2.31recoed and the Margalef Index is 3.72observed with Pielou’s Evenness Index is 0.78 recorded in the look at place **(table-2**).

The excessive species richness of Vespidae in the heterogeneous surroundings which improved assets availability including food and nesting substances in addition to minimum disturbance via people & human disturbance in the form periodic control practices such as elimination of weeds. This take a look at emphasizes the significance of the wooded area ecosystem for Vespid wasps in addition to the lack of research on Vespidae documentation throughout extraordinary atmosphere. In addition studies have to be encouraged in the United States to document and enhance our information of Vespidae diversity and distribution. Greater facts and facts on Vespid wasps will permit us to use Vespidae as an indicator taxon to take a look at the health of surroundings (Hilty and Merenlender 2000) as well as the capability use of Vespid wasps in included Pest management techniques (Gould and Jeanne 1984, Picanco et al. 2010).

**Species Composition and Taxonomic Record**

A 2020 study documented a total of 19 species of Vespidae wasps, belonging to 12 genera and 4 subfamilies:

1. Eumeninae (potter wasps)
2. Polistinae (paper wasps)
3. Stenogastrinae (hover wasps)
4. Vespinae (hornets and yellowjackets)

**Notable genera recorded:**

Antepipona, Delta, Phimenes, Rhynchium, Xenorhynchium (Eumeninae) Polistes, Ropalidia (Polistinae)Vespa (Vespinae) .

**Ecological Observations**

The forest's heterogeneous environment, characterized by high plant diversity, provided optimal niches for Vespidae, supporting species coexistence. Key factors contributing to their diversity included:

1. Abundant food resources (nectar, caterpillars, other insects)
2. Availability of nesting materials (plant fibers, mud)
3. Low human disturbance (limited habitat destruction, minimal pesticide use)
4. Biodiversity Indices and Population Structure
5. Total individuals recorded: 125
6. Species richness (Margalef Index): 3.72 (indicating moderate diversity)

**Diversity indices:**

Simpson’s Index (0.85): High dominance of certain species

Shannon-Wiener Index (2.31): Moderate species diversity

Pielou’s Evenness Index (0.78): Fairly balanced species distribution

**Conservation and Research Implications**

Forest ecosystems are crucial for Vespidae conservation, as they provide essential resources.Limited prior research on Vespidae diversity across different habitats suggests a need for more extensive studies.

Vespidae as bioindicators: Their presence and diversity can indicate ecosystem health.

Potential in pest control: Some species prey on agricultural pests, making them useful in Integrated Pest Management (IPM) strategies.

**Recommendations for Future Studies**

Expand surveys to other habitats (grasslands, urban areas) to assess Vespidae distribution. Investigate their ecological roles (pollination, predation) in greater detail. Promote conservation efforts by minimizing habitat destruction and pesticide use. This study underscores the ecological importance of Vespidae wasps and calls for further research to enhance understanding of their biodiversity and functional roles in ecosystems.

**Table-1: Distribution of texa with sub-family**

|  |  |  |
| --- | --- | --- |
| sn | Species  | subfamily |
|  | *Allorhynchium argentatum* (Fabricius, 1804)  | Eumeninae |
|  | *Antepipona ceylonica* (de Saussure, 1867)  | Eumeninae |
|  | *Antepipona ovalis* (de Saussure, 1853  | Eumeninae |
|  | *Antepipona pruthii* Giordani Soika, 1882  | Eumeninae |
|  | *Antepipona sibilans* (Cameron, 1903)  | Eumeninae |
|  | *Delta conoideum* (Gmelin, 1790)  | Eumeninae |
|  | *Delta pyriforme* (Fabricius, 1775)  | Eumeninae |
|  | *Knemodynerus coriaceus* (Giordani Soika, 1970)  | Eumeninae |
|  | *Labus pusillus van der Vecht, 1963*  | Eumeninae |
|  | *Phimenes flavopictus (Blanchard, 1845* | Eumeninae |
|  | *Rhynchium brunneum* (Fabricius, 1793)  | Eumeninae |
|  | *Xenorhynchium nitidulum* (Fabricius, 1798)  | Eumeninae |
|  | *Polistes* (*Polistella*) *stigma tamulus* (Fabricius, 1798)  | Polistinae  |
|  | *Ropalidia stigma* (Smith, 1858)  | Polistinae |
|  | *Ropalidia jacobsoni* (du Buysson, 1908)  | Polistinae |
|  | *Ropalidia brevita* Das & Gupta, 1989  | Polistinae |
|  | *Ropalidia cyathiformis* (Fabricius, 1804)  | Polistinae |
|  | *Eustenogaster eximia eximioides* (Dover & Rao, 1922)  | Stenogastrinae  |
|  | *Vespa tropica* (Linnaeus, 1758)  | Vespinae  |
|  |  |  |

**Table-2: Statistical analysis**

|  |  |  |
| --- | --- | --- |
| Sn  | Parameter  | Value  |
|  | Total number of species richness | 19 |
|  | Total number of individuals | 125 |
|  | Simpson’s Index of Diversity | 0.85 |
|  | Shannon Weiner Index | 2.31 |
|  | Margalef Index | 3.72 |
|  | Pielou’s Evenness Index | 0.78 |

**Conclusion**

India's rapid population growth and economic development have intensified pressures on natural ecosystems, underscoring the need for sustainable biodiversity conservation strategies. As both pollinators and natural pest controllers, vespid wasps play a vital role in maintaining ecological balance and supporting agricultural productivity. However, despite their importance, comprehensive studies on the diversity and distribution of Vespidae in India remain limited. This study contributes essential baseline data on vespid species composition, offering insights into their ecological significance and the potential impacts of anthropogenic activities on their populations.

The findings highlight the urgent need for further research and conservation efforts to protect these ecologically valuable insects. By integrating vespid wasps into biocontrol programs and habitat management practices, India can reduce reliance on harmful pesticides while promoting sustainable agriculture. Preserving vespid diversity will not only safeguard ecosystem health but also enhance food security in the face of ongoing environmental changes. Future studies should expand taxonomic and ecological assessments across diverse habitats to inform effective conservation policies and ensure the long-term survival of these crucial species.

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