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Diversity and Abundance of Insect Fauna in Agricultural and Riparian Ecosystems of Oney Village, Nashik District, Maharashtra

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Abstract
The study conducted over two years (2022-2024) in Oney village, Nashik district of Maharashtra state - 422302, revealed significant insect biodiversity across various habitats, including agricultural fields, fruit orchards and riverine areas. A total of 36 species across 12 insect orders were identified, with 626 individual insects sampled. The dominant orders were Diptera, Lepidoptera, and Hymenoptera, accounting for over half of the total insect population. Diptera had the highest abundance with 130 individuals, including economically important pests like Melon fly *Bactrocera cucurbitae* and Mango fruit fly *Bactrocera dorsalis,* alongside forensic importance species such as blowflies. Lepidoptera, including pests like *Helicoverpa armigera* and *Spodoptera litura*, posed a considerable threat to crops. Hymenoptera, responsible for pollination and natural pest control, included species like *Apis dorsata* and Oecophylla ants. Other orders, such as Coleoptera, Orthoptera and Thysanoptera, added to the ecological balance. The observed insect-host plant relationships highlight the specificity and complexity in this region's agro-ecosystem. This baseline data establishes the foundation for future detailed studies incorporating statistical diversity analysis and environmental factors, aiding the design of sustainable integrated pest management and conservation strategies in the area.

Keywords: Insect biodiversity, Agro-ecosystem, Dipteral, Integrated Pest Management (IPM), Coleoptera.

Introduction
Insects are the largest, most diverse, successful, and ecologically dominant group of animals on earth. They contribute significantly to ecosystem functioning and have profound impacts on agriculture, human health, and natural resources. Biodiversity, in its broadest sense, includes genetic, species, and ecosystem-level variation (Smith, 1996) [13]. Globally, it is estimated that around 5.5 million insect species exist, of which approximately 1 million species have been formally described (Basset *et al*. 2012) [1]. This makes insects the most species-rich taxon, accounting for more than half of all described eukaryotes. India is recognized as one of the mega diverse countries. Approximately 66,741 insect species are known from India, which represents about 6.5% of the world's insect fauna, and nearly one-third of these species are endemic (Zoological Survey of India, 2021) [16]. Such high richness highlights their ecological importance and the need for systematic biodiversity assessments. The ecological success of insects can be attributed to several features, including small body size, the presence of a chitinous exoskeleton, high fecundity, varied feeding strategies, aerial respiration, and adaptability across habitats. Their ability to fly enhances dispersal and predator avoidance (Fursov, 2004) [4]. In addition, a highly specialized nervous system enables them to see, hear, taste, smell, and sense their surroundings, making them extremely adaptive across ecosystems (Humphrey *et al*. 1999) [5]. Insects exhibit remarkable diversity and are classified into various groups depending on their morphology and habits: Coleoptera (Beetles): Forewings modified into hard elytra protecting hind wings; the largest order with 386,500 described species (Thakare *et al*. 2013) [15]. Lepidoptera (Butterflies and Moths): Possess large, often colorful wings (Muhammad, 2009) [9]. Diptera (Flies): Characterized by a single pair of wings.

Hymenoptera (Ants, Bees, Wasps): Mostly eusocial species, often with stingers; key pollinators and parasitoids. Hemiptera (True Bugs): Equipped with piercing-sucking mouthparts. Orthoptera (Grasshoppers, Crickets): Strong hind legs adapted for jumping; herbivorous (Paulraj *et al*. 2009) [12]. Odonata (Dragonflies, Damselflies): Predatory insects controlling populations of smaller insects. Together, the top five orders Coleoptera, Lepidoptera, Diptera, Hymenoptera, and Hemiptera account for nearly 90% of all described insect species worldwide (Stork, 2018) [14]. Biodiversity studies generally emphasize three levels: genetic, species, and ecosystem diversity (Smith, 1996) [13]. The insect community structure of a habitat strongly influences species survival, community composition, and distribution patterns (Dubey, 2004 [3]; Johri and Johri, 2010) [6] Increasing anthropogenic pressures, habitat fragmentation, and climate change have posed challenges to insect survival (Beeson, 1941) [2]. Conservation strategies must therefore focus not only on individual species but also on the protection of communities and habitats (Kocatas, 2004) [7]. According to Magurran (2004) [8], biodiversity should be assessed at the level of specific geographic areas, with studies comparing species richness and abundance across habitats. This approach is crucial in regions such as Oney village coordinates (Elevation): 560 meters above sea level. The selected study site is Oney village, Niphad taluka, Nashik district, Maharashtra, situated at Latitude: 20.0776° N Longitude: 74.0023° E Altitude with an average altitude of about 560 meters above mean sea level (MSL). The presence of the Banganga River, which is a tributary of the Godavari River, along with surrounding agricultural fields, creates a mosaic of habitats that support rich insect biodiversity. This makes the area a valuable site for entomological research.

Materials and Methods

The present investigation was carried out in diverse habitats such as agricultural farms, fruit orchards and other nearby localities of Oney village, Niphad taluka, Nashik district, Maharashtra - 422302. This site is surrounded by agricultural fields, fruit orchards and riverine ecosystems, providing rural ecological conditions favorable for insect diversity. In addition, specimens were also collected from the surrounding Banganga River basin and adjoining local agricultural fields. Sampling was conducted throughout the year 2022-2024, from January to December, during morning hours (08:00–10:00) and evening hours (15:00–17:00), to comprehensively document the insect diversity of the study area. Insects were collected live from the sampling sites using standard entomological methods such as hand picking, shaking, and beating. The collection equipment included hair brushes, forceps, sticks, hand nets, and killing bottles. Following collection, specimens were transferred into killing bottles prepared from cylindrical glass jars. The sacrificed insects were temporarily stored in insect boxes and subsequently pinned with steel entomological pins for proper drying. To prevent fungal infestation and preserve the specimens, naphthalene balls were placed inside the insect storage boxes. (Prakhar *et al*. 2021) [12]

Fig 1: Stretching of specimen for showcasing

Sampling Procedures

Different insect orders were collected using standardized entomological techniques suited to their habits and habitats. Hemiptera were sampled using aerial nets (for insects in flight), sweeping nets (for low vegetation), and beating of shrubs with a long stick while placing a cloth on the ground to collect the falling insects. Sweeping or beating was performed 5–6 times per plant. Specimens obtained were preserved in 70% alcohol for identification. Orthoptera were collected using aerial nets, butterfly nets, and hand-picking with the aid of large forceps. Hymenoptera and Coleoptera were sampled by both beating and sweeping techniques. Plant parts were struck with a stick using downward strokes to dislodge insects, performed 4–5 times per plant. Larger flying hymenopterans were additionally trapped using sweep nets. Collected specimens were either stored in vials with 70% alcohol or killed in killing bottles. Lepidoptera (adult butterflies) were captured using butterfly nets from multiple microhabitats, including flowers and overripe fruits. (Prakhar *et al*. 2021) [12]

Table 1: Occurrence of different insect diversity with their host

S.N	Order	Family/S. Family	Scientific name	Common name	Hosts	Occurrence
1	Lepidoptera	Noctuidae	*Spodoptera litura*	Tobacco caterpillar	Tomato	25
2	Lepidoptera	Noctuidae	*Helicoverpa armigera*	Gram pod borer/ Tomato fruit borer	Tomato, Gram, Maize	39
3	Lepidoptera	Gelechiidae	*Tuta absoluta*	South American tomato pinworm	Tomato	20
4	Lepidoptera	Arctidae	*Spilosoma obliqua*	Bihar hairy caterpillar	Soybean	15
5	Lepidoptera	Noctuidae	*Anomis flava*	Okra caterpillar, Semilooper	Okra	10
6	Lepidoptera	Sphingidae	*Daphnis nerii*	Oleander hawk-moth	Periwinkle	2
7	Lepidoptera	Crambidae	*Chilo infuscatellus*	Early shoot borer	Sugarcane	7
8	Lepidoptera	Crambidae	*Scirpophaga excerptalis*	Top shoot borer	Sugarcane	6
9	Lepidoptera	Gelechiidae	*Aproaerema modicella.*	Groundnut leaf miner.	Groundnut	5
10	Coleoptera	Coccinellidae	*Coccinella septempunctata*	Seven-spotted lady bird/beetle	Observed on tomato, sugarcane, grape, while feeding on aphids and other soft –bodied pests.	16
11	Coleoptera	Coccinellidae	*Cheilomenes sexmaculata*	Six-spotted zigzag lady bird/beetle	Observed on wheat, while feeding on aphids and soft –bodied pests.	20
12	Coleoptera	Meloidae	*Mylabris pustulata*	Blister beetle, Hycleus beetle	Pigeon pea, Maize	5
13	Coleoptera	Scarabaeidae	*Holotrichia serrata*	White grub	Sugarcane, Groundnut	24
14	Coleoptera	Cerambycidae	*Obereopsis brevis*	Girdle beetle	Soybean	7
15	Coleoptera	Cerambycidae	*Batocera rufomaculata*	Mango stem borer	Mango	5
16	Coleoptera	Scarabaeidae	*Oryctes rhinoceros*	Rhinoceros beetle	Coconut	3
17	Orthoptera	Tettigoniidae	*Sathrophyllia* spp.	Spear grass katydid.	Curryleaf,	6
18	Orthoptera	Gryllotalpidae	*Gryllotalpa africana*	African mole cricket.	Green plants	8
19	Orthoptera	Acrididae	*Schistocerca gregaria*	Migratory locust/Desert locust	Maize	15
20	Diptera	Culicidae	*Culiceta longiareolata*	Mosquito	On host animals	13
21	Diptera	Muscidae	*Musca domestica*	Housefly/ Mouche domestique.	Poultry and Dairy	14
22	Diptera	Tephritidae	*Bactrocera cucurbitae*	Melon fly	Cucumber	33
23	Diptera	Tephritidae	*Bactrocera dorsalis*	Mango fruit fly	Mango	25
24	Diptera	Agromyzidae	*Liriomyza trifolii*	Serpentine leaf miner	Tomato	12
25	Diptera	Calliphoridae	*Chrysomya megacephala*	Blowfly	Near fresh carrion	33
26	Dermaptera	Labiduridae	*Labidura riparia*	Striped earwig	Soil	34
27	Isoptera	Termitidae	*Odontotermes obesus*	Termite	Wheat and other host plants.	23
28	Ephemeroptera	Leptophlebiidae	*Indialis rossi*	Mayfly	Around river.	4
29	Odonata	Libellulidae	*Rhyothemis variegata*	Dragonfly	Near river, Pond	6
30	Hymenoptera	Apidae	*Apis dorsata*	Honeybee	Floral plants	22
31	Hymenoptera	Formicidae	*Oecophylla smaragdina*	Weaver ant, Green tree ant	Floral plants	35
32	Hymenoptera	Formicidae	*Monomorium pharaonis*	Pharaoh ant	Near sweet substance	34
33	Mantodea	Mantidae	*Mantis religiosa*	Praying mantis	Leaves of different crops.	25
34	Thysanoptera	Thripidae	*Scirtothrips dorsalis*	Chilli thrips	Onion, Grape	23
35	Thysanoptera	Thripidae	*Thrips parvispinus*	Tobacco thrips	Chilli	27
36	Hemiptera	Pseudococcidae	*Maconellicoccus hirsutus*	Grape mealybug	Grape	25
Total	12	36				626

Fig 2: Pining of insects from different orders.

Results

The present study conducted in Oney village, Niphad Taluka, Nashik district, Maharashtra-422302, documented a rich and diverse insect fauna over the period from 2022 to 2024. Sampling from various habitats including agricultural farms, fruit orchards, riverine areas, and adjacent agricultural fields led to the collection of insects belonging to 12 different orders, encompassing a total of 36 species-level taxa (Table 1). The total number of individuals recorded was 626, indicating a considerable abundance and diversity of insect fauna in this semi-urban ecosystem characterized by a mosaic of agricultural and natural habitats. Among the insect orders recorded, the highest species richness and abundance were noted in the orders Diptera (flies), Lepidoptera (butterflies and moths), and Hymenoptera (Bees, Ants, Wasps), which collectively accounted for nearly 55% of the total individuals collected. Diptera was the most abundant order with 130 individuals, including economically important pests such as *Bactrocera cucurbitae* (Melon fly), *Bactrocera dorsalis* (Mango fruit fly), and forensic importance species like *Chrysomya megacephala* (Blowfly). Lepidoptera contributed 129 individuals, with species such as *Helicoverpa armigera* (Gram pod borer/Tomato fruit borer) and *Spodoptera litura* (Tobacco caterpillar) dominating the collection. Hymenoptera, comprising mostly pollinators and natural enemies like *Apis dorsata* (Giant honeybee), *Oecophylla smaragdina* (Weaver ant), and *Monomorium pharaonis* (Pharaoh ant), accounted for 91 individuals. Other notable orders included Coleoptera (Beetles) with 80 individuals, Thysanoptera (Thrips) with 50 individuals, and Orthoptera (Grasshoppers, Crickets) with 29 individuals. Lower abundances were recorded for Dermaptera (Earwigs), Isoptera (Termites), Ephemeroptera (Mayflies), and Odonata (Dragonflies). The total species and individual counts reflect the varied habitat types and ecological niches present in and around Oney village. The abundance data suggest specialized host-plant affiliations with many species linked to economically important crops such as tomato, sugarcane, soybean, grape, groundnut, and mango have long been recognized as major threats to crops across India and the world. Their significant presence in Oney village suggests that these pests remain persistent and require integrated pest management (IPM) strategies to mitigate crop losses. The observed richness and diversity of insect fauna in Oney village align well with previous studies conducted in similar agro-ecosystems. The dominance of key orders such as Diptera, Lepidoptera, and Hymenoptera in terms of species richness and abundance corroborates findings from several researchers. For instance, Painkra, G. and Thakare, V. G. and Zade, V. S. and Hegde, V. D. documented a comparable diversity pattern in Ground beetles (Coleoptera: Carabidae), emphasizing the ecological importance of Coleopteran species in agricultural landscapes. Similarly, Haldar, P. Bhandar, K.P. and Nath's observations on Indian grasshoppers, *Acrida exaltata* (Orthoptera: Acrididae), parallel the current study's findings regarding Orthopteran diversity and host plant specificity. Furthermore, Parandham, D.'s investigations into butterfly diversity across various habitats reinforce the extensive presence of Lepidopteran species reported here. Research by Muhammad, A., on moth fauna diversity, species richness, and evenness, also supports the current results, highlighting the prevalence of Lepidoptera as both economically significant pests and critical components of biodiversity. Notably, the outcomes of this study are consistent with the detailed assessments presented by Painkra, and Painkra (2018) [11], who explored similar diversity indices, thereby offering robust external validation. Collectively, these parallels underscore the reliability of the present findings and accentuate the ecological significance of the identified insect groups in the sustainable management of agro-ecosystems in the region.

Conclusion

The study conducted in Oney village, Nashik district of Maharashtra state reveals a rich insect diversity spanning 12 orders and 36 species, with a total of 626 individuals recorded. Dominant orders included Diptera, Lepidoptera, and Hymenoptera, collectively accounting for over half the total insect population. Diptera, with 130 individuals, featured significant pest species like melon and mango fruit flies and forensic importance species such as blowflies. Lepidoptera included key pests like *Helicoverpa armigera* and *Spodoptera litura*, posing challenges to crop health. Hymenoptera, important for pollination and pest control, comprised species like *Apis dorsata* and Oecophylla ants. The strong association of insects with specific host plants indicates focused pest pressures and ecological roles. While the study offers valuable baseline data, integrating statistical diversity measures and environmental factors in future research will enhance understanding and aid sustainable pest management. This work establishes a foundational understanding of the insect community essential for effective agricultural and ecological planning in the region

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