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Exploring Insect Pollinator-Plant Dynamics in Murud, Raigad District Maharashtra

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Abstract

The current study investigates insect visitor diversity and their roles in plant-pollinator interactions in the Murud area, aiming to enhance fertilization and agricultural productivity. Identifying 37 insect species across three orders and nine families, with Lepidoptera and Hymenoptera showing the highest diversity, underscores their vital role as pollinators. Additionally, 18 plant species, attracting a variety of pollinators like butterflies, bees, flies, beetles, hoverflies, and bumblebees, contribute to ecosystem biodiversity and support robust pollinator populations. The interplay between plants and insects, exemplified by species like *Crinum asiaticum* and *Rosa indica,* emphasizes the complexity of ecosystem dynamics and underscores the importance of maintaining diverse plant communities for sustaining healthy pollinator populations. Increased awareness among farmers about pollination mechanisms could lead to enhanced crop yields, strengthening the economy.

***Key words*:** Bees, Insect, Pollinator, Fertilization, Plant-pollinator interactions

Pollination stands as a pivotal biological process vital for the effective transfer of pollen grains from the mature anther to the stigma of flowers, thereby facilitating fertilization crucial for seed and fruit production [1-2]. This intricate process engages a range of both biotic and abiotic agents, each evolving specific strategies over time [3-4]. Abiotic pollination relies on non-living agents like wind, water, and rain, while biotic pollination involves living organisms such as insects, birds, and mammals, including bats, which actively participate as pollinators and benefit from plant nectar [5-7]. Flowers secrete nectar from their stigma, rich in essential nutrients such as carbohydrates, fats, vitamins, proteins, minerals, and other phytochemicals [3], [5].

Insect pollinators, in particular, hold significant importance in upholding ecosystem functions [8], with their absence potentially disrupting pollination processes, underscoring their critical role in flowering plant reproduction and ecological equilibrium [4], [9-10]. Natural ecosystems exhibit diverse environmental gradients and mutualistic relationships among pollinator species, with more pronounced variations in tropical regions compared to temperate zones [11-13]. According to Food and Agriculture Organization (FAO) estimates, over 100 crop species, fulfilling 90% of global food demand, rely on various biotic pollinators, especially insects [14] of the roughly 180,000 flowering plant species, approximately 1,200 are vital crops entirely reliant on pollinators for global agricultural productivity [15-16]. Pollinators serve indispensable roles in agriculture, plant reproduction, ecology, and environmental health, rendering invaluable services to humanity [17]. Delving into plant-pollinator relationships and implementing conservation efforts proves essential for preserving biodiversity and ensuring food security [4], [18]. The current study aims to explore the diversity of insect visitors and their involvement in plant-pollinator interactions in the Murud area of Maharashtra's Raigad district. By comprehending the timing and types of pollinators associated with various plants, the research endeavors to contribute to successful fertilization and enhance agricultural productivity. Heightened awareness among farmers regarding pollination mechanisms has the potential to augment crop yields and bolster the economy [18].

MATERIALS AND METHODS

Study area: The observation was conducted in Murud Taluka, located within Raigad district along the Konkan Coast of Maharashtra, India. Raigad district is bordered by the Sahyadri ranges to the east, with Pune and Satara districts situated to the southeast. Fieldwork was carried out extensively in the study area of Murud Taluka from 2022 to 2023 to observe the plant-pollinator interactions among the various crops and wild verities.

Sampling procedure: Visual samplings of pollinator visits were conducted weekly in flower strips and agricultural crops within the study area. Sampling occurred between 09:00 and 14:00, considering suitable weather conditions conducive to foraging activities of pollinator visitors. Each week, observations commenced at different locations based on random sampling strategies [19-20].

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Data collection: Insect species were meticulously recorded while they visited various flowering herbs, shrubs, and trees, encompassing both cultivated and wild species present in the study area. Additionally, an exhaustive inventory of plants of economic importance was compiled, and their associated pollinators were identified through a systematic review of literature and available information [21].

Classification of pollinators: Pollinator groups were classified based on their respective insect orders and families prevalent in the study area. This classification facilitated the investigation of pollination mechanisms and the relationship between pollinators and plants, drawing upon established frameworks outlined by [22-23].

Data analysis: Findings from field observations, including plant and insect characteristics, were meticulously documented, and photographic evidence was collected. Identification and authentication of plant species and their visiting insects were conducted using relevant botanical and entomological literature, research papers, reports, and botanical floras. The collected data were summarized in tabular formats and elucidated in accompanying textual descriptions, providing insights into the observed plant-pollinator interactions within the study area. These findings contribute to a deeper understanding of pollination dynamics and ecosystem functioning in the Murud Taluka region of Raigad district, Maharashtra.

RESULTS AND DISCUSSION

(a). *Insect flower visitors*

A total of 37 species of insects were identified from flowers of studied flowering plants species. The result excludes very small insects that were insignificant of carrying pollens. Identified insects belong to 3 orders, 9 families. The representative orders were. Lepidoptera, Hymenoptera. Lepidoptera and Hymenoptera showed highest species diversity then others, respectively (Table 1).

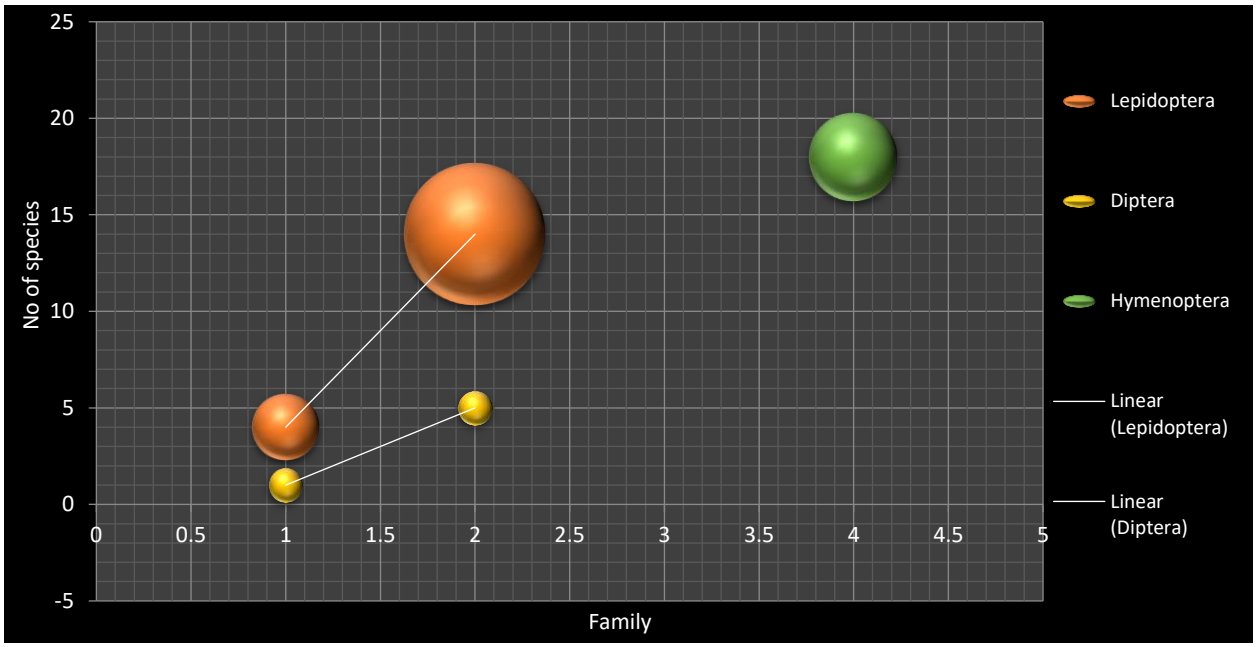
Presents a diverse array of insect species, comprising 37 entries distributed across four distinct orders. Among these, Lepidoptera, representing butterflies, emerges as the most prominent order, featuring 14 species spread across five families. Notably, the Hymenoptera order, inclusive of bees, ants, and wasps, accounts for the largest number of species, totaling 17, distributed across six families. Additionally, Diptera, characterized by hoverflies, contributes five species, while one species each is attributed to the Hymenoptera order, outside of bees and wasps (Table 2). This rich assortment showcases the intricate biodiversity within the insect of Murud area, highlighting their varied roles and ecological significance as pollinators and contributors to local ecosystem dynamics.

Table 1 Recorded insect visitors on flowers with their classification

S. No.	Name of insect	Order	Family	Insect class
1	*Appias lyncida*	Lepidoptera	Pieridae	Butterfly
2	*Catopsilia pyranthe*			
3	*Papilio ulysses*		Papilionidae	
4	Papilionini spp.			
5	*Euploea core*		Nymphalidae	
6	*Auploea spp.*			
7	*Tirumala limonis*			
8	*Hypolimnas spp.*			
9	*Ithomiini spp.*			
10	*Charaxes spp.*			
11	*Deudorix spp.*		Lycaenidae	
12	*Celastrina spp.*			
13	*Agriades spp.*			
14	*Agapetes spp.*			
15	*Apis dorsata*	Hymenoptera	Apidae	Bee
16	*Trigona spp.*			
17	*Anthophora pubescens*			
18	*Amegilla spp.*			
19	*Teratohmia spp.*			
20	*Lipotriches spp.*			
21	*Ceratina spp.*			
22	*Nomadinae spp.*			
23	*Xylocopa pubescens*			
24	*Apes mellifera*			Honey bees
25	*Apis florea* F.,			
26	*Bombus haemorrhoidalis* Smith			Bumble bee
27	*Xylocopa* spp.			Carpenter Bee
28	*Halictus ligatus*		Halictidae	Bee
29	*Lasioglossum spp.*			
30	*Pachycondyla madraspatana*		Formicidae	Ant
31	*Pachycondyla lepida*			
32	*Ropalidia spp.*		Vespidae	Paper Wasp
33	*Palpada spp.*	Diptera	Syrphidae	Hoverfly
34	*Epistrophe spp.*			
35	*Milesiini spp.*			
36	*Myathropa florea*			
37	*Mallota spp.*			

Table 2 Distribution of order among family, species and class of insect

Order	Family	No. of species	Class of insect
Lepidoptera	4	14	1
Hymenoptera	4	18	7
Diptera	1	5	1
Total	9	37	9



Graph 1 Graphical distribution of insect visitor's species and their numbers

Table 3 Distribution of plants and relations with insect visitor class

S. No	Plants name	Plant family	Common name	Insect visitor class
1	*Crinum asiaticum* L.	Amaryllidaceae	Crinam lily	Butterfly, Bee
2	*Rosa indica*	Rosaceae	Rose	Bee, Butterfly
3	*Catheranthus roseuses*	Apocynaceae	Graveyard plant	Butterfly, Bee
4	*Tagetes lucida*	Asteraceae	Marigolds	Bee, Butterfly
5	*Hibiscus rosa-sinensis*	Malvaceae	China rose	Butterfly, Bee, Flies
6	*Ixora coccinea*	Rubiaceae	Jungle geranium	Butterfly, Bee
7	*Haldina cardifolia*	Rubiaceae	Haldu	Honey bees, Flies
8	*Clerodendron serratum*	Verbenaceae	Bharangi	Bee, Butterfly, Flies
9	*Celosia argentea*	Amaranthaceae	Red Fox	Flies, beetles
10	*Lantana camera*	Verbenaceae	Lantana	Butterfly, Bee
11	*Combretum indicum*	Combretaceae	Rangoon creeper	Bee, beetles
12	*Argemone mexicana*	Papaveraceae	Mexican poppy	Flies, beetles
13	*Calatropis procera*	Apocynaceae	Sodom apple	Beetles, Bee,
14	*Strobilanthes integrifolius*	Acanthaceae	Ranbhokari	Hoverfly, Bumble bee
15	*Urena sinuata*	Malvaceae	Vanbhendi	Butterfly, Bumble bee
16	*Gloriosa superba*	Colchicaceae	Flame lily	Flies, beetles
17	*Mangifera indica* L.	Anacardiaceae	Mango	Flies, beetles
18	*Cuminum cyminum* L.	Apicaceae	Cumin	Honey bees, Flies

(b). *Major plant visited by insects*

The Raigad district in Maharashtra exhibits a remarkable array of plants that are frequented by insects for pollination purposes. A total of 18 plant species were selected based on comprehensive observations of insect visitors and pollinators within the study area (Table 2).

i. *Crinum asiaticum* L. (Amaryllidaceae): This perennial bulbous plant is characterized by its large, trumpet-shaped flowers that bloom in shades of white, pink, or red. Crinum Lily attracts a variety of pollinators, including butterflies and bees, with its sweet-scented nectar, contributing to ecosystem biodiversity and floral diversity in gardens and landscapes [24].

ii. *Rosa indica* (Rosaceae) - Rose: Renowned for its exquisite beauty and captivating fragrance, the Rose is one of the most iconic and beloved flowering plants worldwide. Its blooms, available in a myriad of colors and forms, attract an array of pollinators, including bees and butterflies, facilitating cross-pollination and ensuring reproductive success [25].

iii. *Catharanthus roseus* (Apocynaceae) - Graveyard plant: This evergreen perennial is prized for its delicate, star-shaped flowers, which bloom in shades of white, pink, or purple. Graveyard Plant serves as a valuable nectar source for butterflies and bees, playing a crucial role in supporting pollinator populations and maintaining ecosystem balance [26].

Crinum asiaticum L.

Rosa indica

Catheranthus roseuses

Tagetes lucida

Hibiscus rosa-sinensis

Ixora coccinea

Plate 1

iv. *Tagetes lucida* (Asteraceae) - Marigolds: These annual or perennial herbaceous plants are renowned for their cheerful, daisy-like flowers that come in shades of yellow, orange, or maroon. Marigolds attract bees and butterflies with their abundant nectar, enhancing garden biodiversity and serving as natural pest repellents due to their strong aroma [27].

v. *Hibiscus rosa-sinensis* (Malvaceae) - China rose: This evergreen shrub or small tree is characterized by its large, showy flowers in shades of red, pink, orange, yellow, or white. China Rose attracts a diverse range of pollinators, including butterflies, bees, and flies, with its nectar-rich blooms, contributing to ecosystem health and floral diversity [28].

vi. *Ixora coccinea* (Rubiaceae) - Jungle geranium: This evergreen shrub is cherished for its dense clusters of small, tubular flowers that bloom in vibrant shades of red, orange, yellow, or pink. Jungle Geranium attracts butterflies and bees with its nectar-rich blooms, serving as a valuable food source for pollinators and enhancing garden beauty [29].

i. *Haldina cardifolia* (Rubiaceae) - Haldu: This deciduous tree is esteemed for its durable timber and medicinal properties. Haldu's flowers attract honey bees and flies with their sweet nectar, supporting pollinator populations and promoting ecosystem resilience [30].

ii. *Clerodendron serratum* (Verbenaceae) - Bharangi: This perennial shrub is valued in traditional medicine for its therapeutic properties. Bharangi's tubular flowers attract bees, butterflies, and flies, serving as important pollinator resources and contributing to the plant's reproductive success [31].

iii. *Celosia argentea* (Amaranthaceae) - Red fox: This annual or perennial plant is characterized by its striking, flame-shaped inflorescences in shades of red, orange, or yellow. Red fox attracts flies and beetles with its abundant pollen and nectar, facilitating pollination and promoting genetic diversity in the ecosystem [32].

Haldina cardifolia

Clerodendron serratum

Celosia argentea

Lantana camera

Combretum indium

Argemone Mexicana

Plate 2

iv. *Lantana camara* (Verbenaceae) - Lantana: Perennial shrub, native to the American tropics, is prized for its colorful, aromatic flowers that bloom in clusters. Lantana attracts butterflies and bees with its abundant nectar, serving as a valuable food source for pollinators and enhancing garden biodiversity [33].

v. *Combretum indicum* (Combretaceae) - Rangoon creeper: This vigorous, woody vine is renowned for its fragrant, trumpet-shaped flowers that transition from white to pink to red as they mature. Rangoon creeper attracts bees and beetles, which play essential roles in its pollination and seed dispersal, contributing to its reproductive success and genetic diversity [34].

vi. *Argemone mexicana* (Papaveraceae) - Mexican poppy: Annual or biennial herbaceous plant is characterized by its prickly stems and bright yellow or white flowers. Mexican poppy attracts flies and beetles with its pollen and nectar, facilitating pollination and contributing to ecosystem functioning [35].

i. *Calotropis procera* (Apocynaceae) - Sodom apple: Also known as Milkweed or Rubber Bush, this perennial shrub is valued for its latex and medicinal properties. Sodom Apple attracts beetles and bees with its fragrant flowers, which produce copious amounts of nectar, supporting pollinator populations and enhancing ecosystem biodiversity [36].

ii. *Strobilanthes integrifolius* (Acanthaceae) - Ranbhokari: Perennial herb, native to India, is characterized by its lanceolate leaves and blue-purple flowers that bloom in spikes. Ranbhokari attracts hoverflies and bumblebees with its nectar-rich blooms, facilitating pollination and promoting plant reproduction [37].

iii. *Urena sinuata* (Malvaceae) - Vanbhendi: (*U. lobata*) Annual herb is prized for its edible leaves and medicinal properties. Vanbhendi attracts butterflies and bumblebees with its showy flowers, providing them with essential nectar and pollen resources and supporting pollinator populations [38].

iv. i*Gloriosa superba* (Colchicaceae) - Flame lily: Striking perennial herb is characterized by its flame-like, red and yellow flowers with reflexed petals. Flame Lily attracts flies and beetles with its nectar, facilitating pollination and ensuring the continuation of its life cycle [39].

v. *Mangifera indica* L. (Anacardiaceae) - Mango: Iconic tropical fruit tree is prized for its delicious and nutritious mango fruits. Mango flowers attract flies and beetles with their sweet scent, aiding in pollination and fruit set, ultimately contributing to mango production and biodiversity in orchards [40].

vi. *Cuminum cyminum* L. (Apiaceae) - Cumin: Aromatic annual herb is renowned for its distinctive flavor and culinary uses. Cumin flowers attract honey bees and flies with their nectar, supporting pollinator populations and promoting genetic diversity in cumin crops [41].

Calatropis procera

Strobilanthes integrifolius

Urena sinuata

Gloriosa superba

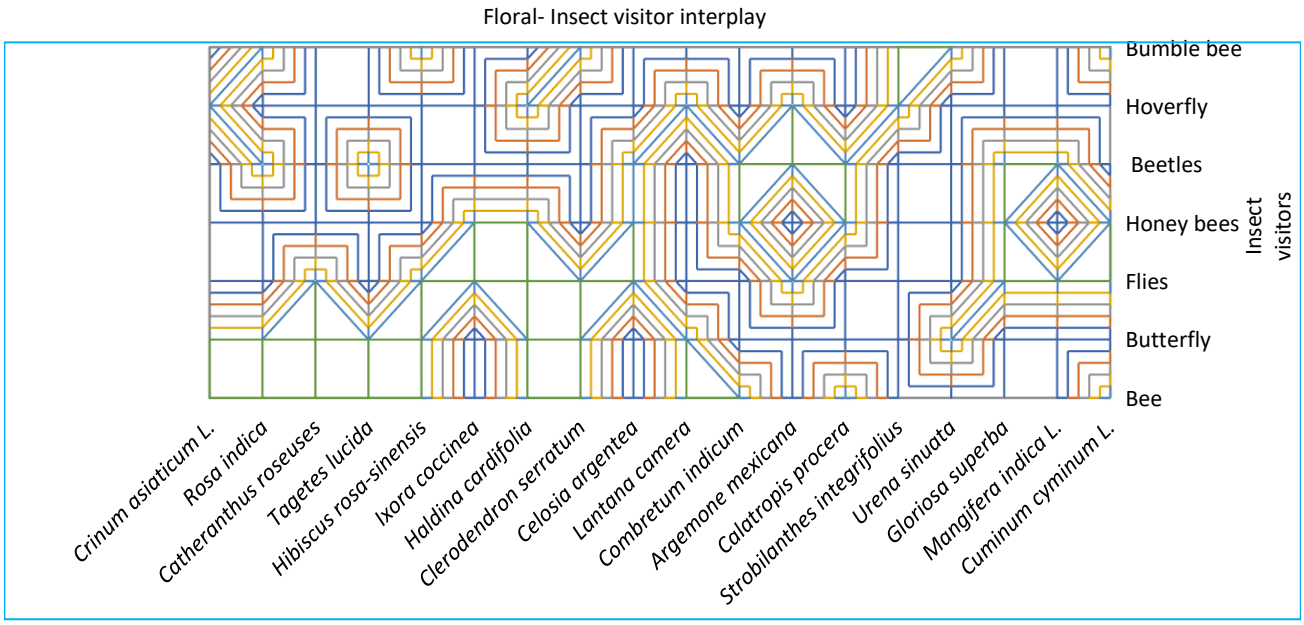
Mangifera indica

Cuminum cyminum

Plate 3

Table 3 Floral-insect visitor interplay

S. No.	Plants name	Insect visitor						
		Bee	Butterfly	Flies	Honey bees	Beetles	Hoverfly	Bumble bee
1	*Crinum asiaticum* L.	1	1	0	0	0	1	0
2	*Rosa indica*	1	1	0	0	1	0	1
3	*Catheranthus roseuses*	1	1	1	0	0	0	0
4	*Tagetes lucida*	1	1	0	0	1	0	0
5	*Hibiscus rosa-sinensis*	1	1	1	0	0	0	1
6	*Ixora coccinea*	0	0	1	1	0	0	0
7	*Haldina cardifolia*	1	1	1	1	0	1	0
8	*Clerodendron serratum*	1	1	1	0	0	0	1
9	*Celosia argentea*	0	0	1	1	1	0	0
10	*Lantana camera*	1	1	0	0	0	1	0
11	*Combretum indicum*	1	0	0	1	1	0	0
12	*Argemone mexicana*	0	0	1	0	1	1	0
13	*Calatropis procera*	1	0	0	1	1	0	0
14	*Strobilanthes integrifolius*	0	0	0	0	0	1	1
15	*Urena sinuata*	0	1	0	0	0	0	1
16	*Gloriosa superba*	0	0	1	1	1	0	0
17	*Mangifera indica* L.	0	0	1	0	1	0	0
18	*Cuminum cyminum* L.	1	0	1	1	0	0	1



Graph 2 Graphical representation of interrelationships between floral-insect visitors

CONCLUSION

In terms of insect flower visitors, the research conducted in the Murud area identified a total of 37 insect species across three orders and nine families. Notably, Lepidoptera and Hymenoptera exhibited the highest species diversity, with butterflies and bees being particularly prominent. This diverse assemblage of insect visitors underscores their crucial role as pollinators and contributors to the local ecosystem. Regarding the major plants visited by insects, the study observed 18 plant species serving as important sites for pollination. These plants, spanning various families, attract a diverse array of pollinators, including butterflies, bees, flies, beetles, hoverflies and bumblebees. This interaction between plants and insects plays a pivotal role in fostering ecosystem biodiversity, enhancing floral diversity, and supporting robust pollinator populations. The interrelationship between floral-insect visitors highlights the nuanced dynamics at play within ecosystems. Different plant species attract specific combinations of insect species, with examples like *C. asiaticum* and *R. indica* drawing a varied range of visitors, including bees, butterflies and beetles. This intricate interplay emphasizes the complexity of ecosystem dynamics & underscores the importance of maintaining diverse plant communities to sustain healthy pollinator populations.

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