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Diversity of Bees and Butterflies on *Tridax Procumbens:* A Study in Abu Road, Sirohi, Rajasthan

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Abstract: ***The current study was conducted from April 2021 to November 2023 in Chandravati village and its surrounding agricultural areas and forest patches in Abu Road, Sirohi, Rajasthan. The main objective of study is to know about the diversity of bees and butterflies visiting the flowers of the coat buttons (Tridax procumbens) plant. A total of 39 insect species were documented, comprising 29 species from 05 families within the order Lepidoptera (butterflies) and 10 species from 03 families within the order Hymenoptera (bees). Members of the Lycaenidae family were found to be dominant with (10) number of species followed by Nymphalidae (9), Pieridae (5), Papilionidae (3) and the least Hesperiidae (2). Along with, A total 10 species of bees belonging to three families viz. with resepect number of species - Apidae (6 species), Halictidae (1 species), and Megachilidae (3 species) were observed on study plant. Bees like Apis florea (24 visits), Apis dorsata (19 visits), and Ceratina smaragdula (15 visits) were dominant in pollination during the study period because their visitation rates are higher. Among the butterflies, Spialia galba (7 visits), Catochrysops strabo (6 visits), and Danaus chrysippus (5 visits) show notable activity. Other species, like Amegilla fallax (7 visits), was demonstrated considerable visitation among the bees. The bees, especially honeybees were appeared to be more frequent visitors, which aligns their ecological role in pollination, whereas butterfly visits are more sporadic but still important for pollination.***

Keywords: Bee Diversity, Butterfly Diversity, *Tridax procumbens*, Rajasthan

1. Introduction

Butterflies belong to a large insect group called Lepidoptera (meaning scaly winged). In the butterfly, there are two main groups; Skippers are in the Hesperiodea group, and all the other butterflies are in the Papilionoidea group. Butterflies play a crucial ecological and cultural role in India, particularly in Rajasthan, where they contribute to pollination, biodiversity conservation, and environmental monitoring. As pollinators, they aid in the reproduction of native flora, including several medicinal and economically significant plants (Kunte, 2000). Their presence is often used as an indicator of ecosystem health, with species like *Papilio demoleus* and *Euchrysops cnejus* serving as bioindicators of habitat quality and climate change in Rajasthan's arid and semi - arid landscapes (Sharma & Sharma, 2020). However, habitat loss and climate change threaten their populations, emphasizing the need for conservation efforts to protect Rajasthan's butterfly diversity and the ecological balance they support.

The order Hymenoptera, which includes bees, wasps, ants, and sawflies, plays a critical role in ecological stability and agricultural sustainability. Hymenopterans, particularly bees, are among the most efficient pollinators, significantly contributing to the reproductive success of numerous flowering plants and enhancing biodiversity (Michener, 2007). In addition to pollination, many parasitic wasps serve as biological control agents, regulating pest populations and reducing the need for chemical pesticides (Godfray, 1994). Economically, honeybees (*Apis* spp.) are vital for honey and wax production, while their pollination services enhance the yield and quality of agricultural crops. Bees are among the most effective pollinators, responsible for fertilising approximately 75% of flowering plants and 35% of global crop production (Klein et al., 2007). Their unique morphology, such as body hairs and pollen - carrying structures like corbiculae, allows them to transfer pollen efficiently from one flower to another, enabling plant reproduction. This pollination process ensures the formation of fruits, seeds, and nuts, which are critical for food security and biodiversity (Potts et al., 2010).

Pollinators, particularly bees, are essential for maintaining ecological balance. By enabling plant reproduction, they support the growth of vegetation that provides food and habitat for other organisms, thus sustaining terrestrial ecosystems. Wild bees, in particular, pollinate native plants, contributing to the stability of natural ecosystems (Garibaldi et al., 2013). Additionally, they aid in the genetic diversity of plant populations, which enhances ecosystem resilience to environmental changes.

Bees indirectly contribute to environmental health by ensuring the proliferation of plants that prevent soil erosion, sequester carbon, and regulate microclimates. Pollinated plants, especially trees and shrubs, play a vital role in reducing greenhouse gases and maintaining the water cycle (Steffan - Dewenter et al., 2005). Furthermore, their interactions with native flora promote the regeneration of natural habitats and support wildlife populations. The pollination services provided by bees are valued at billions of dollars annually. Crops like almonds, apples, and sunflowers rely heavily on bee pollination, directly supporting global food systems (Losey & Vaughan, 2006).

Declines in bee populations due to habitat loss, pesticide use, and climate change threaten food production and biodiversity. Habitat destruction, agricultural intensification, pesticide exposure, and climate change pose significant threats to bee populations (Vanbergen & the Insect Pollinators Initiative, 2013). Protecting natural habitats, reducing pesticide usage, and promoting bee - friendly practices are critical for conserving these indispensable pollinators. Bees play an essential role in global food security by enhancing crop pollination and improving the quality and yield of various agricultural products, but their sustainability is threatened by factors such as climate change, pesticides, and land management, necessitating efforts to protect and support bee populations for continued pollination services (Khalifa et. al.2021). Bees are crucial pollinators that significantly impact food security and biodiversity but face various threats that affect their role in the ecosystem (Bahgat, 2023). *Tridax procumbens*, with its dual - floret structure and nutrient - rich nectar, supports diverse pollinators and exhibits a complex pollination ecology dominated by butterflies, bees, and thrips (Varalakshmi and Raju (2013).

T. procumbens, commonly referred to as coat buttons or *Tridax* daisy, is a flowering plant species belonging to the Asteraceae family, commonly known as the sunflower family. According to Powell (1965), approximately 26 species of *Tridax* are distributed across tropical America, with *T. procumbens* being the most widespread species. It is well - known for its invasive nature and is often considered a common weed. Native to Mexico and other tropical American regions, *T. procumbens* has spread globally, adapting to tropical, subtropical, and mild temperate climates, reflecting its ecological versatility (Weber, 2003).

Morphology of study plant: *T. procumbens* thrives in tropical and semi - tropical climates and is commonly found in a variety of disturbed habitats, including fields, meadows, croplands, lawns, roadsides, and other open areas. The study herb is a perennial, characterized by a creeping stem that aids in its rapid spread. The plant produces daisy - like flowers with white or yellow petals and a central yellow disc made up of three - toothed ray florets. Its leaves are often arrow - shaped with toothed margins, a distinctive feature for identification. This wide adaptability and effective seed dispersal mechanism make it a successful invasive species across many regions. The fruit of the plant is a rigid achene covered with stiff hairs. *T. procumbens* is classified as an invasive species due to its prolific seed production, capable of yielding up to 1, 500 hard achenes per plant. These achenes, which have a plumose pappus, are easily spread by wind. This lets the plant spread quickly and compete with native plants, which upsets the ecosystems in the area (Figure 3).

Despite its invasive nature, *T. procumbens* holds significant traditional medicinal value, particularly in India. It has been widely used for wound healing and exhibits anticoagulant, antifungal, and insect - repellent properties. Additionally, indigenous healers in various parts of India use *T. procumbens* for treating boils, blisters, and cuts, highlighting its importance in traditional medicine (Gupta et. al.2013). This dual nature underscores the plant's ecological impact and cultural relevance. *T. procumbens* demonstrates significant therapeutic potential due to its bioactive compounds, particularly in wound healing and chronic disease treatment, highlighting its promise as a valuable resource for future drug discovery and development.

Chemical Constituents: *T. procumbens* has been found to contain various bioactive chemical compounds, which contribute to its medicinal properties. One of the key flavonoids isolated from the aerial parts of *T. procumbens* is procumbenetin. It also has alkyl esters, sterols, pentacyclic triterpenes, fatty acids, and polysaccharides, all of which have been studied for their possible health benefits (Jhample et al., 2015). Despite these promising findings, there is a lack of detailed toxicological data on *T. procumbens*. More research is necessary to better understand the plant's safety, side effects, and overall impact on health (Meena & Singh, 2018). This study aims to contribute further to the ecological knowledge of *T. procumbens*, specifically examining its role in pollination by analysing butterfly foraging behaviours. Understanding the interaction between this plant and pollinators can provide insights into its ecological importance, in addition to its medicinal uses.

2. Materials and Methods

T. procumbens, commonly known as coat buttons or Tridax daisy, is a flowering species belonging to the family Asteraceae. The study was conducted in Chandravati village and around the agricultural lands of Abu Road Tehsil in Sirohi District, Rajasthan, India (Figure 1). The semi - arid to tropical climate characterizes Abu Road Tehsil, which is located in the southern part of Rajasthan. It features a mix of agricultural lands and forest patches, providing diverse habitats for pollinators. The study area includes agricultural fields, meadows, roadsides, and disturbed habitats that are often present near human settlements.

The study was conducted over a period from April 2021 to November 2023. Pollinator and foraging activity surveys were conducted weekly during the flowering period of *T. procumbens*. Observations were conducted between 10: 00 AM and 4: 00 PM, as these hours corresponded to the peak visitation rates of pollinators. Regular field surveys were conducted at designated intervals to ensure consistency. Flower - visiting pollinators were captured when necessary; specimens were captured (only bees) using insect hand nets for detailed examination and identification. Collected specimens were kept in insect storage boxes. A Nikon digital camera (D - 5600) equipped with an 18–55 mm lens was used to photograph butterflies and bees for identification and behavioral studies. Identification of butterflies and bees was done using field guides and comparison with reference materials (Isaac Kehimkar, 2016, and Michener, 2007).

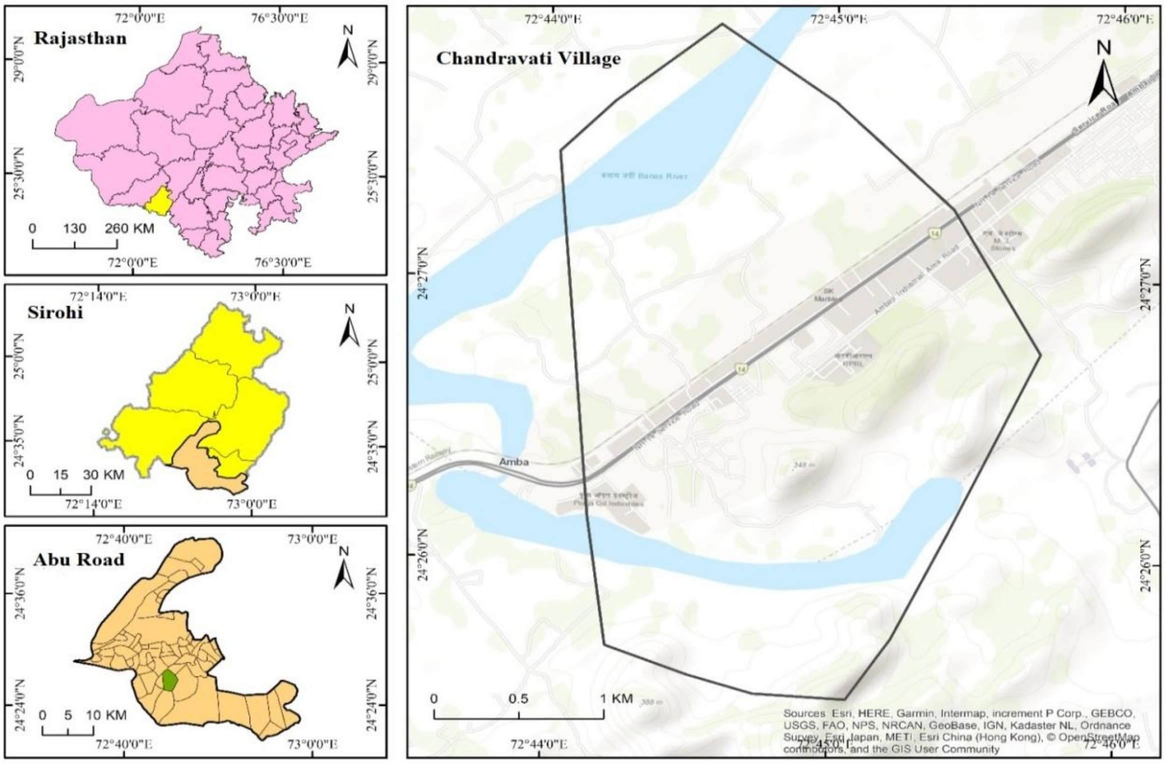

Figure 1: The location of the study area

Figure 2: Adjoining Landscape of Study area

Figure 3: Flower of *T. procumbens*

3. Result and Discussion

The present study documented the diversity of butterflies and bees on *T. procumbens* in Chandravati village and its surrounding areas in Abu Road Tehsil, Rajasthan, between April 2021 and November 2023. A total of 39 species of bees and butterflies were reported (Image 1 - 23) and out of them, 29 species are under the order Lepidoptera and belong to five families: Lycaenidae (10 species), Nymphalidae (9 species), Pieridae (5 species), Papilionidae (3 species), and Hesperiidae (2 species). The order Hymenoptera has 10 species spread across three families: Apidae (5 species), Megachilidae (3 species), and Halictidae (1 species) (Figure 4).

The most visits were from *A. florea* (24 visits), *A. dorsata* (19 visits), and *C. smaragdula* (15 visits). This suggests that these species are very important for pollinating study crop. Bees were observed to frequently visit the flowers, reinforcing the understanding that bees are essential for effective pollination in agricultural landscapes. Among the butterflies, *Spialia galba* (7 visits), *Catochrysops strabo* (6 visits), and *Danaus chrysippus* (5 visits) were the most active, but overall, butterfly visitation was relatively less frequent than that of bees. Species such as *Zizula hylax* and *Papilio polytes* had very low visitation rates; with only one visit each (Table 1.1).

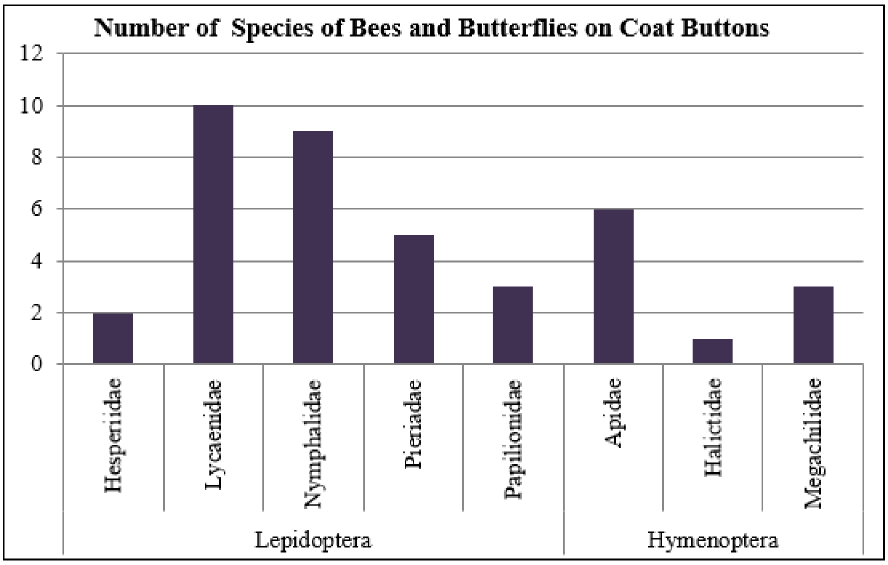

Figure 4: Diversity of Butterflies and Bees on the Coat Button Herbs from Abu Road, Rajasthan

The high number of visits by bees is in line with their ecological role as primary pollinators. Honeybees, in particular, have been shown to prefer flower plant species that have lots of nectar and pollen sources. The lower visitation rates of butterflies suggest that they do contribute to pollination, but less than bees. The species - specific visitation patterns observed, with certain butterfly species such as *Spialia galba* and *Danaus chrysippus* visiting more often, underscore the potential for different pollinator guilds to engage with the plant in specific ways. Also, *T. procumbens* has been used traditionally in India as medicine to treat wounds, fungal infections, and blood clots. This shows that the plant is important for both the environment and people. This integration of ecological and medicinal knowledge reinforces the importance of conserving the study plant, not only for its role in pollinator health but also for its cultural value in traditional medicine. The agricultural fields host flowering weeds like *T. procumbens*, which attract butterflies and bees, while the forest areas support native biodiversity and offer essential ecological resources.

4. Conclusion

The study of bee and butterfly diversity on *T. procumbens* in Abu Road, Rajasthan is essential for understanding their ecological roles, conservation needs, and impacts on ecosystem stability. *T. procumbens* holds significant potential as a natural source for drug development, particularly for wound healing and the treatment of chronic diseases (Arbaz et. al.2024). Bees are primary pollinators of many crops and wild plants, directly influencing food security and biodiversity, while butterflies serve as both pollinators and bio - indicators of environmental health. Their distributions pattern help assess habitat quality, climate change effects, and anthropogenic pressures. The study highlights a diverse range of species actively interacting with plants within the observed timeframe. *T. procumbens* has traditionally been used in India by indigenous healers for wound healing, as an anticoagulant, antifungal, insect repellent, and for treating boils, blisters, and wounds, highlighting its medicinal significance (Ingole et al., 2022). In regions like Rajasthan, where ecosystems range from arid landscapes to forested areas, studying these pollinators provides insights into species adaptation and habitat connectivity. Their declining populations highlight the need for habitat protection, climate - resilient conservation strategies, and policies that promote pollinator - friendly landscapes. Future research and conservation efforts should focus on mitigating threats such as habitat loss, pesticide use, and climate change to ensure the long - term survival of these vital pollinators.

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Photographs of Butterflies and Bees on Coat Buttons from the study area (Image 1 - 23):

			
1. *Pelopidas mathias* (Fabricius, 1798)	2. *Spialia galba* (Fabricius, 1793)	3. *Catochrysops strabo* (Fabricius, 1793)	4. *Jamides celeno* (Cramer, 1775)
			
5. *Euchrysops cnejus* (Fabricius, 1798)	6. *Zizeeria karsandra* (Moore, 1865)	7. *Tarucus nara* (Kollar, 1848)	8. *Talicada nyseus* (Guérin - Méneville, 1843)

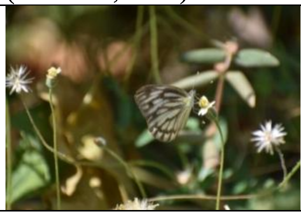
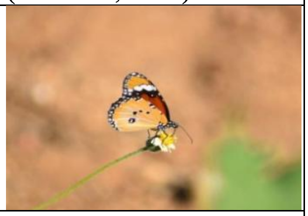
			
9. *Hypolimnas misippus* (Linnaeus, 1764)	10. *Junonia almana* (Linnaeus, 1758)	11. *Junonia orithya* (Linnaeus, 1758)	12. *Catopsilia pomona* (Fabricius, 1775)
			
13. *Eurema andersonii* (Moore, 1886)	14. *Eurema hecabe* (Linnaeus, 1758)	15. *Cepora nerissa* (Fabricius, 1775)	16. *Danaus chrysippus* (Linnaeus, 1758)
			
17. *Catopsilia pyranthe* (Linnaeus, 1758)	18. *Freyeria putli* (Kollar 1844)	19. *Apis florea* (Fabricius, 1787)	20. *A. dorsata* (Fabricius, 1793)
			
21. *Amegilla fallax* (Smith, 1879)	22. *Ceratina smaragdula* (Fabricius, 1787)	23. *Megachile gathela* (Cameron, 1908)	

Table 1.1: Observation of Butterflies on *T. procumbens*

Sr. No.	Number of Visits on Plants (m^2/5 minutes)	Scientific Name	Family	Order
1	3	*Pelopidas mathias* (Fabricius, 1798)	Hesperiidae	Lepidoptera
2	7	*Spialia galba* (Fabricius, 1793)		
3	6	*Catochrysops strabo* (Fabricius, 1793)	Lycaenidae	
4	4	*Jamides celeno* (Cramer, 1775)		
5	3	*Euchrysops cnejus* (Fabricius, 1798)		
6	3	*Zizeeria karsandra* (Moore, 1865)		
7	5	*Tarucus nara* (Kollar, 1848)		
8	4	*Talicada nyseus* (Guérin - Méneville, 1843)		
9	2	*Castalius rosimon* (Fabricius, 1775)		
10	1	*Zizula hylax* (Fabricius, 1775)		
11	3	*Freyeria putli* (Kollar 1844)		
12	2	*Luthrodes pandava* (Horsfield, 1829)		
13	2	*Hypolimnas misippus* (Linnaeus, 1764)	Nymphalidae	
14	1	*Acraea terpsicore* (Linnaeus, 1758)		
15	2	*Phalanta phalantha* (Drury, 1773)		
16	2	*Ariadne merione* (Cramer, 1777)		
17	1	*Junonia lemonias* (Linnaeus, 1758)		
18	2	*J. hierta* (Fabricius, 1798)		
19	5	*Danaus chrysippus* (Linnaeus, 1758)		
20	3	*Junonia almana* (Linnaeus, 1758)		
21	5	*J. orithya* (Linnaeus, 1758)		
22	2	*Catopsilia pomona* (Fabricius, 1775)	Pieriadae	
23	2	*Eurema andersonii* (Moore, 1886)		
24	3	*E. hecabe* (Linnaeus, 1758)		
25	5	*Cepora nerissa* (Fabricius, 1775)		

26	4	*Catopsilia pyranthe* (Linnaeus, 1758)		
27	1	*Pachliopta aristolochiae* (Fabricius, 1775)	Papilionidae	
28	1	*Papilio polytes* (Linnaeus, 1758)		
29	1	*Graphium agamemnon* (Linnaeus, 1758)		
30	7	*Amegilla fallax* (Smith, 1879)	Apidae	Hymenoptera
31	19	*Apis dorsata* (Fabricius, 1793)		
32	24	*A. florea* (Fabricius, 1787)		
33	12	*A. mellifera* (Linnaeus, 1758)		
34	15	*Ceratina smaragdula* (Fabricius, 1787)		
35	9	*Amegilla zonata* (Linnaeus, 1758)		
36	11	*Nomia westwoodi* (Gribodo, 1894)	Halictidae	
37	7	*Megachile lanata* (Fabricius, 1775)	Megachilidae	
38	8	*Megachile coelioxysides* (Bingham, 1898)		
39	9	*M. gathela* (Cameron, 1908)		