

Diversity And Relative Abundance of Different Pollinators in Cucumber (*Cucumis sativus* L.)

ABSTRACT

The study on insect pollinator diversity and their abundance on cucumber flowers was conducted at the Vegetable Research Station, Agricultural Research Institute, Rajendranagar, Hyderabad during 2023-2024. A total of 25 species, including 13 species of Hymenoptera, five species of Diptera, five species of Lepidoptera and two species of Coleoptera were documented. Of which, Hymenoptera was found to be most abundant, accounting for 72.17% followed by Diptera at 16.49%. Among the families, Apidae was observed as most dominant, with a high abundance and species diversity at 49.48% followed by Syrphidae at 9.28%. The families Sphecidae, Hesperidae, and Calliphoridae each had the least abundance at 1.03%. *Apis dorsata* Fabricius was reported as most abundant species at 12.37% followed by *Apis cerana indica*, *Ceratinabinghami* Cockerell and *Camponotus compressus* Fab. each at 8.25%. The species *Acraea terpsicore* (0.82%) had the lowest abundance. In recent years due to urbanization and fragmentation a decreased trend in pollinator activity had been observed so this research provides the base line data about the existing pollinator species diversity in the study area which offer insights for taking appropriate management practices to conserve the pollinator species.

Keywords: Species diversity; pollinator; abundance; Hymenoptera; Apidae

1. INTRODUCTION

Pollinators are vital for the pollination of numerous cross-pollinated crops, as these crops typically cannot depend on self-pollination. Insect pollinators are necessary for the fruit and seed production of many cross-pollinated crops. Over 90% of tropical plants are pollinated by various pollinating agents, majorly comprising two-thirds of insects as pollinators [22]. Insects are widely recognized as the most effective agents of pollination in the world's terrestrial ecosystems [12] and the interaction between flowering plants and pollinators are considered as mutualistic symbiosis.

Cucumber (*Cucumis sativus* L.) is one of the oldest vegetables that is cultivated world-wide in tropical and subtropical parts of the world [8]. Cucurbitaceae is one of the important families which includes many vegetables belonging to cucurbits [9]. It consists of 122 genera and 940 species which are distributed widely in tropical and subtropical regions of the world. Cucurbitaceae is an economically significant family, with many domesticated species, among which cucumber is one of the most common and widely cultivated worldwide. Cucumber flowers are monoecious and open for one day [14] with maximum pollination during forenoon hours. Cucumber flowers have wrinkled petals and a yellow colour. A wide range of insect pollinators are drawn to the vast amounts of nectar produced

by both the male and female [6]. It is grown over an area of 116000 hectares with a production of 1608000MT in India [2]. Pollinators must be present during this time period in order to get the fruits to be set. The quality of the fruits also depends on pollinator services [1]. Studies have consistently confirmed that proper pollinator utilization can increase yield levels up to 100 to 150% in cucurbitaceous crops [10]. Hymenopterans, with their diverse pollinator taxa, are recognized as the most efficient and predominant pollinators compared to other pollinator groups. Honey bees from Hymenoptera are considered as major pollinators on cucumber. Honeybees pollinate 16% of total of 0.25 million of flowering plant species in the world and nearly 40,000 species of agricultural plants [5]. Honey bee pollination increases productivity and quality of the yield. The widespread application of agricultural chemicals, especially insecticides, has been identified as a major factor contributing to the decline of pollinators. These pesticides can be highly toxic to bees, causing immediate death or disrupting their foraging activities [16]. Unfortunately, pollinator diversity has been significantly declining in recent years due to urbanization and habitat fragmentation [19]. In many developed countries, efforts are being made to manage insect pollinators. However, in developing countries, there is limited knowledge about pollinating insects. Therefore, understanding their diversity and abundance is crucial for conserving pollinators. This study aims to document the diversity and abundance of various pollinators in cucumber fields.

2. MATERIAL AND METHODS

Present study was conducted during 2023-24 at Vegetable Research Station (VRS), Agricultural Research Institute, Rajendranagar, Hyderabad. The study area is located at 17° 20' N latitude and 78° 30' E longitude with an altitude of 573 meters from mean level. The diversity studies were carried out in an experimental area of 500 square meters. A spacing of 0.5 cm was maintained between plant to plant. Diversity and abundance of different insect pollinators was studied using various trapping methods like water pan trap, sweep nets and aspirator. Observations from these traps were recorded at weekly intervals from 10 per cent to 90 per cent flowering. The collected species were preserved as both wet and dry specimens. The specimens were identified with assistance from experts at the National Centre for Biological Sciences (NCBS), GKVK in Bengaluru and the Indian Institute of Rice Research (IIRR) in Rajendranagar, Hyderabad.

The relative abundance of species was calculated using the formula given below.

Relative abundance (%) = $N_i \div N_A \times 100$ (MacArthur, 1960) [15]

Where,

N_i = Total number of individual pollinator species

N_A = Total number of pollinator species

Shannon-Wiener Diversity index (Shannon, 1948) It was used to measure community diversity. It takes the number of individuals as well as the number of taxa into account Shannon, 1948 [20]. The formula used for calculation-

$$H = - \sum P_i \ln P_i$$

Where, $P_i = S / N$

S = number of species

N = total number of individuals

\ln = logarithm to base e

Simpson index: It considers the number of species as well as the abundance of each species. It is measured by subtracting the value of D from 1 Simpson Index (Simpson, 1949) [21]. The formula used for calculation -

$$D = \sum n_i (n_i - 1) / N(N-1)$$

where, n_i = Total number of individuals of a particular species

N = Total number of individuals of all species

3. RESULTS AND DISCUSSION

3.1 Diversity of insect pollinators on cucumber

A total of 485 individuals were collected throughout the study from the cucumber flowers. These included 25 species from 13 families across four orders: Hymenoptera (350 individuals), Lepidoptera (27 individuals), Diptera (80 individuals) and Coleoptera (28 individuals). Among the collected species Hymenopterans were found to be major pollinators followed by Lepidoptera. Among the Hymenopterans 13 species were recorded from four families. They were *Tetragonula* sp., *Apis florea* Fabricius, *A. cerana indica*, *A. dorsata* Fabricius, *C. binghami* Cockerell, *Ceratinaheiroglyphica* Smith, *Ceratinasmaragdula*, *Xylocopa* sp. and *Amegilla* sp. from family Apidae, *Nomia* sp. from Halictidae, *Camponotus compressus* Fab. and *Solenopsis* sp. from Formicidae and *Sceliphron madraspatanum* Fab. from Sphecidae. Among the Lepidopterans, species like *Danaus chrysippus* Linn. and *Acraea terpsicore* L. (Nymphalidae), *Eurema hecabe* and *Colotisdanae* Fabricius (Pieridae) and *Baoris* sp. (Hesperiidae) were observed. The rest of the species belong to Diptera (five species from four families) and Coleoptera (two species from two families). These included *Musca* sp. (Muscidae), *Sarcophaga* sp. (Sarcophagidae), *Chrysoma* sp. (Calliphoridae), *Ischidonscutellaris* Fabricius and *Eristalinus quinquestriatus* Fabricius (Syrphidae) from Diptera, and *Cheilomenessexmaculata* (Coccinellidae) and *Aulacophora foveicollis* (Chrysomelidae) from Coleoptera. Different species of pollinators recorded during the study were listed in Table 1.

The present findings align with some of the earlier works like Nishchith *et al.* [14] who recorded 19 species from 13 families across five orders (Hymenoptera, Lepidoptera, Diptera, Coleoptera, and Hemiptera) were recorded. *Solenopsis* sp., *Musca* sp., *Sarcophaga* sp., *Eristalis* sp., *C. sexmaculata*, *Coccinella septempunctata*, *Illeiscincta* and *Aulacophora* sp. were recorded during his study. Kurniawan *et al.* [13] documented 15 pollinator species from the orders Hymenoptera, Lepidoptera and Diptera, noting Hymenoptera as the most abundant group. Balachandran *et al.* [3] identified *A. dorsata*, *A. cerana* and *Trigona* sp. as pollinators of cucurbits in Karnataka. Similar findings were reported by Bano *et al.* [4], who documented insect pollinators belonging to the orders Hymenoptera and Diptera. Kannagi *et al.* [11] reported 36 species comprising 9 sps (vespidae), 7 species (Apidae), 8 species (Formicidae), 5 species (sphecidae) 3 species (Meghachilidae). While halictidae, pompillidae, chrysilidae and mutilidae represented one species each.

Table 1. List of insect pollinators of cucumber (*Cucumis sativus* L.)

S.No	Common Name	Scientific Name	No. of Visitors	Family	Order
1.	Stingless bee	<i>Tetragonula</i> sp.	15	Apidae	Hymenoptera
2.	Indian little bee	<i>Apis florea</i> Fabricius	20		
3.	Indian honey bee	<i>Apis cerana indica</i>	40		
4.	Rock bee	<i>Apis dorsata</i> Fabricius	60		
5.	Small carpenter bee	<i>Ceratinabinghami</i> Cockerell	40		
6.	Small carpenter bee	<i>Ceratinaheiroglyphica</i> Smith	20		
7.	Emerald Small Carpenter	<i>Ceratinasmaragdula</i>	10		
8.	Carpenter bee	<i>Xylocopa</i> sp.	5		
9.	Blue banded bee	<i>Amegilla</i> sp.	30		
10.	Alkali bee	<i>Nomia</i> sp.	35	Halictidae	
11.	Common black ant	<i>Camponotus compressus</i> Fab.	40	Formicidae	
12.	Tropical fire ants	<i>Solenopsis</i> sp.	30		

13.	Black mud-dauber wasps	<i>Sceliphronmadraspatanum</i> Fab.	5	Sphecidae	
14.	Plain tiger	<i>Danaus chrysippus</i> Linn.	6	Nymphalidae	Lepidoptera
15.	Tawny coster	<i>Acraea terpsicore</i> L.	4		
16.	Common grass yellow	<i>Euremahecabe</i>	8	Pieridae	
17.	Crimson tip	<i>Colotisdanae</i> Fabricius	4		
18.	Paint brush swift	<i>Baoris</i> sp.	5	Hesperiidae	
19.	Housefly	<i>Musca</i> sp.	20	Muscidae	Diptera
20.	Flesh fly	<i>Sarcophaga</i> sp.	10	Sarcophagidae	
21.	Blow fly	<i>Chrysoma</i> sp.	5	Calliphoridae	
22.	Common hover fly	<i>Ischidonscutellaris</i> Fabricius	30	Syrphidae	
23.	Hover fly	<i>Eristalinusquinquestratus</i> Fabricius	15		
24.	Six-spotted zigzag ladybird	<i>Cheilomenessexmaculata</i>	8	Coccinellidae	Coleoptera
25.	Red pumpkin beetle	<i>Aulacophorafoveicollis</i>	20	Chrysomelidae	

3.2. Relative abundance of insect pollinators on cucumber

Relative abundance of different pollinator species on cucumber flowers are listed in Table 2. Hymenopterans made up the majority of floral visitors at 72.17%, followed by Diptera at 16.49%, Coleoptera at 5.77%, and Lepidoptera at 5.57%. Among Hymenopterans, *A. dorsata* Fab. from the Apidae family was most prevalent at 12.37%, followed by *A. cerana indica*, *C. binghami* Cockerell and *C. compressus*, each accounting for 8.25% of the total abundance. In contrast, *Xylocopa* sp. and *S. madraspatanum* Fab. were the least abundant hymenopteran species, each representing 1.03% of the total. The Apidae family alone accounted for the majority of the abundance, contributing 49.48% (Fig 1.). Dipterans were noted as the second most abundant group after Hymenopterans. The Syrphidae family had the highest abundance at 9.28%, while the Calliphoridae family was the least frequent at 1.03%. Among Diptera, *I. scutellaris* Fabricius was the most abundant pollinator, making up 6.19% of the total. Lepidopterans and Coleopterans were observed to be less abundant, possibly influenced by weather conditions.

These findings are in conformity with Nishchith *et al.* [17] who reported that *A. cerana* had the highest prevalence among the Apidae family (Hymenoptera), accounting for 3.45%, followed by *A. florea* at 2.38% and *A. dorsata* Fabricius at 0.42%. Hymenopterans collectively represented 75% of the total abundance. Patel and Pastagia, [18] stated that honey bees belonging to Hymenoptera are the most abundant pollinators of cucumbers, accounting for 70.45%, followed by Coleopterans (9.34%), Hemipterans (9.09%), Lepidopterans (7.58%) and Dipterans (3.54%). Harisha and Shanas[7] observed that *A. cerana indica* was the predominant pollinator in various gourd crops in Kerala.

3.3 Shannon-Wiener Diversity index (Shannon, 1948)

In the present study, Shannon-Wiener Diversity index from cucumber is (H=2.941) which reveals the community diversity for both the abundance and evenness of the species. The present findings are in accordance with Kannagi *et al.* [9] observed that the Shannon's diversity index (H) reached its highest value among Hymenopterans (H=1.95), which closely aligns with the findings of the present study. Yogapriya *et al.* [23] reported a maximum Shannon diversity index of 2.52 for insect pollinators, which is nearly similar to the present study, where we observed a value of 2.735 for bitter gourd.

3.4 Simpson index (Simpson, 1949)

In the present study, Simpson index from cucumber is (0.7571). it is the community diversity by assessing the probability of two individuals belonging to the same species, ranging from

0 to 1. The findings are similar to Nishchithet *al.* [17] who recorded Simpson index (D) for species richness of insect pollinators was 0.2162 in cucumber. Yogapriya *et al.* [23] reported that the highest value of the Simpson index as 0.22-0.40 in bitter gourd.

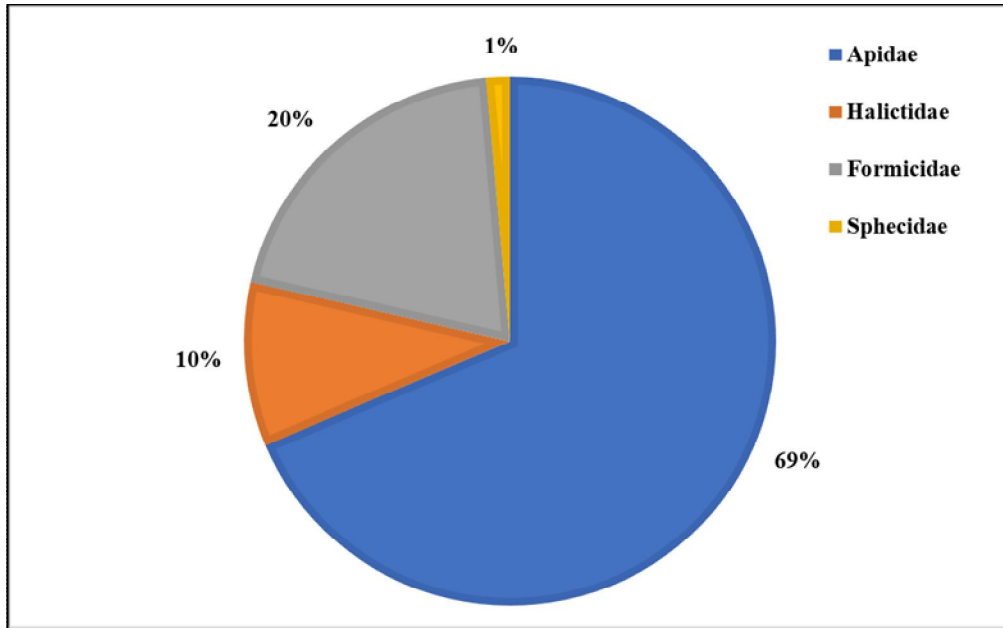


Fig 1. Relative abundance (%) of pollinators from Hymenopteran families

Table 2. Relative abundance of insect pollinators on cucumber (*Cucumis sativus* L.)

Order	Family	Species	Abundance (%)	Total abundance (%)
Hymenoptera	Apidae	Tetragonula sp.	3.09	72.17
		Apis florea Fabricius	4.12	
		Apis cerana indica	8.25	
		Apis dorsata Fabricius	12.37	
		Ceratinabinghami Cockerell	8.25	
		Ceratinaheiroglyphica Smith	4.12	
		Ceratinasmaragdula	2.06	
		Xylocopa sp.	1.03	
		Amegilla sp.	6.19	
		Nomia sp.	7.22	
	Halictidae	Nomia sp.	7.22	
Formicidae	Camponotus compressus Fab.	8.25		
	Solenopsis sp.	6.19		
Sphecidae	Sceliphron madraspatanum Fab.	1.03		
Lepidoptera	Nymphalidae	Danaus chrysippus Linn.	1.24	

		Acraea terpsicore Linn.	0.82	5.57
	Pieridae	Euremahecabe	1.65	
		Colotisdanae Fabricius	0.83	
	Hesperiidae	Baoris sp.	1.03	
Diptera	Muscidae	Musca sp.	4.12	16.49
	Sarcophagidae	Sarcophaga sp.	2.06	
	Calliphoridae	Chrysoma sp.	1.03	
	Syrphidae	Ischidonscutellaris Fabricius	6.19	
		Eristalinusquinquestriatus Fabricius	3.09	
Coleoptera	Coccinellidae	Cheilomenessexmaculata	1.65	5.77
	Chrysomelidae	Aulacophorafoveicollis	4.12	

CONCLUSION

Cucumber flowers with bright yellow coloured flowers attracts a diverse range of diurnal pollinators. Pollinator fauna of cucumbers belong to four insect orders. Among them, Hymenopterans showed the highest abundance and species diversity. Bees from the Apidae family were predominantly observed, but non-Apis bees also contributed significantly to pollination. This study provides valuable insights for conserving pollinator diversity and suggests measures for conservation efforts.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.option 1

2.

3.

REFERENCES

1. Abrol D P, Gorka A K, Ansari M J, Al-Ghamdi A, Al-Kahtani S. 2019. Impact of insect pollinators on yield and fruit quality of strawberry. *Saudi Journal of Biological Sciences*. 2019; 26(3): 524-530
2. Area, Production, Productivity of cucumber 2022; <https://static.pib.gov.in/WriteReadData/specificdocs/documents/2022/mar/doc202232832101>.
3. Balachandran C, Chandran S, Vinay S, Shrikant N, Ranachandra TV. Pollinator diversity and foraging dynamics on monsoon crop of cucurbits in a traditional landscape of South Indian west coast. 2017; *Biotropia*. 24(1): 16-27.
4. Bano P, Khursheed R, Mushtaq H, Ganie SA, Paray MA, Pathania SS, Sherwani A, Arifie U. Quantification and Role of Insect Pollinators in Enhancing Productivity in Cucumber. *Biological Forum – An International Journal*. 2023; 15(9): 547-551.
5. Crane E, Walker P. Pollination directory for world crops. International Bee Research Association, London. 1984. 183-185.
6. Dan S, Murungi LK, Kioko E. Diversity and abundance of insect pollinators and their effect on yield and quality of cowpea and cucumber in Makueni, Kenya. *African Journal of Horticultural Science*. 2019; 16: 43-54
7. Harisha E, Shanas S. Relative abundance and foraging activity of hymenopteran pollinators in cucurbitaceous vegetables. *Entomon*. 2019; 44(4): 259-268.
8. Hossain MS, Yeasmin F, Rahman MM, Akhtar S, Hasnat MA. Role of insect visits on cucumber (*Cucumis sativus* L.) yield. *Journal of Biodiversity Conservation and Bioresource Management*. 2018; 4(2): 81-88.
9. Khambhu CV, Pandya HV, Patel HA, Ghetiya LV, Vaja SJ. Biodiversity and activity period of insect pollinators in cucumber *Cucumis sativus* L. *The Pharma Innovation Journal*. 2023; 12(6): 4868-4872.
10. Kishan Tej M, Srinivasan M R, Rajashree V, Thakur R K. 2017. Stingless bee *Tetragonulairidipennis* Smith for pollination of greenhouse cucumber. *Journal of Entomology and Zoology Studies* 5: 1729-1733.

11. Kannagi A, Sivakumar V, Santhi V. Diversity of dragonflies (Insecta: Odonata) in a deciduous forest of Thoothukudi district, Tamil Nadu, South India. *International Journal of Environmental Protection and Policy*. 2016;4(3):58-63.
12. Klein A, Vaissière BE, Cane JH, Stefan-Dewenter I, Cunningham SA, Kremen C, Tscharntke T. Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society*. 2007; 274 (1608): 303–313.
13. Kurniawan B, Putra D, Anggriani L, Manurung AQ, El Widah M. Diversity of pollinators in cucumber plantation on organic and conventional farming in Jambi. In *Religion, Education, Science and Technology towards a More Inclusive and Sustainable Future*. 2024; 285-291.
14. Lord, WG. Successful cucumber production will continue to depend on honey bees in the near future. *American Bee Journal*. 1985; 125: 623-625.
15. MacArthur R. 1960. On the relative abundance of species. *The American Naturalist*. 1960; 94(874): 25-36.
16. Nakasu, E. Y., Williamson, S. M., Edwards, M. G., Fitches, E. C., Gatehouse, J. A., Wright, G. A., & Gatehouse, A. M. (2014). Novel biopesticide based on a spider venom peptide shows no adverse effects on honey bees. *Proceedings of the Royal Society of London B: Biological Sciences*, 281, 20140619
17. Nishchith S, Reddy NA, Ramegowda GK, Krishna HC. Studies on insect pollinator diversity, species richness, and evenness on Cucumber (*Cucumis sativus* L.) in the Eastern Dry Zone of Karnataka. *Biological Forum*. 2023; 15(5): 1460-1465.
18. Patel DH, Pastagia JJ. Abundance of different flower visitors and their foraging behaviour in cucumber (*Cucumis sativus* L.). 2022; 10(6): 91-95.
19. Potts SG, Imperatriz-Fonseca V, Ngo HT, Aizen MA, Biesmeijer JC, Breeze TD, Dicks LV, Garibaldi LA, Hill R, Settele J. Safeguarding pollinators and their values to human well-being. *Nature*. 2016; 540 (7632): 220-229.
20. Shannon CE. A mathematical theory of communication. *The Bell system technical journal*. 1948;27(3):379-423.
21. Simpson EH. Measurement of diversity. *Nature*

22. Siregar EH, Atmowidi T, Kahono S. Diversity and abundance of insect pollinators in different agricultural lands in Jambi, Sumatera. *Hayati Journal of Biosciences*. 2016; 23:13-17.
23. Yogapriya, A., Usharani, B and Suresh, K. Diversity and foraging activity of flower visitors/pollinators of *Momordica charantia* L., in Tamil Nadu, India. *Entomon*. 2022; 47(1): 41-50.

UNDER PEER REVIEW

A. dorsta *A. cerana indica*



C. binghami *C. compressus*



Nomia sp. *Aulacophora foveicollis*



Ischiodon scutellaris

Fig 2. Pollinator fauna recorded on cucumber

UNDER PEER REVIEW