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Preliminary Survey of Araneae and Insect Diversity in the Botanical Garden of D.K.V. Arts & Science College, Jamnagar, Gujarat, India

Devanshi Pandya and *Foram P Patel

Biology Department (Zoology),

D K V Arts & Science College,

P N Marg, JAMNAGAR-361008 (GUJARAT) INDIA

*Corresponding Author

E-mail : patelforam9795@gmail.com

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ABSTRACT

The present study examines insect diversity in the Botanical Garden of D K V Arts & Science College, Jamnagar, Gujarat, employing quadrat (50x50 cm) method. The garden hosts 87 plant and 6 grass species, with *Tecoma stans* being notably prevalent. Besides, density, abundance and frequency were assessed using 110 quadrats. A total of 88 species were observed during the survey, including both insects and spiders. Study reveals a rich and varied community dominated by ants from the Formicidae family. Noteworthy findings include a rare spider species *Emertonella taczanowskii* has been recorded for the first time in Jamnagar, Gujarat. The findings highlight the complex ecological relationships between the diverse insect population and the garden's flora, emphasizing the need for further taxonomic research to identify the many unidentified species and understand their ecological significance.

Figures : 02 References : 22 Tables : 02

KEY WORDS : Abundance, Botanical Garden, Density, Frequency, Insect Diversity, Quadrat method

Introduction

Insects are the largest, most diverse, and most dominant group of organisms on Earth [10]. Classified under the class Insecta, phylum Arthropoda, and kingdom Animalia, insects play key ecological roles, including pollination, nutrient cycling, and serving as prey for many species[12]. Similarly, spiders, classified in the order Araneae within the class Arachnida and phylum Arthropoda, rank seventh in global species diversity among all animal groups[20]. As predators, spiders play a vital role in maintaining ecological balance by regulating prey populations[6].

The diversity and abundance of insects are frequently used as indicators of overall biodiversity and environmental health, especially when specific philopatric or indicator species are selected for biomonitoring[5]. However, insect populations in India face increasing threats from land-use changes, pesticide use, and climate variability[16]. Urbanization and habitat fragmentation have further compounded these threats, leading to a decline in insect diversity[11]. Despite their ecological significance, regional studies on insect diversity are limited. Likewise, though spiders are widely distributed across India, research on their diversity and ecology remains sparse[6].

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TABLE–1 : Range of diversity indices during the study Period

	November	December	February
Simpson's Diversity Index	0.77 - 0.83	0.60 - 0.75	0.67 - 0.87
Shannon Diversity Index	1.69 - 1.90	1.27 - 1.86	1.49 - 2.60

Gujarat is known for its rich diversity of both insects and spiders, as several studies have demonstrated. Over 1,500 species of insects in the region, and Gir Forest National Park is recognized as a hotspot for undiscovered insect species[17]. Most research on spider diversity in Gujarat has been conducted in protected areas[7, 8, 18], with only a few studies focusing on urban environments[9, 22]. Although Gujarat's semi-arid and deciduous landscapes support significant biodiversity, studies on both insect and spider diversity in urban areas remain scarce [1,9].

In Jamnagar, a few reports have offered some insights into local insect diversity[3], but there is still a considerable knowledge gap. This study seeks to address this gap by assessing the insect and spider diversity in the botanical garden of D.K.V. Arts & Science College, Jamnagar, providing baseline data that can guide future conservation and management efforts.

Materials and Methods

Study Area : The study was conducted in the botanical garden of D.K.V. Arts & Science College, Jamnagar, Gujarat, India (Latitude: 22.48090, Longitude: 70.06905, Altitude: 7.77 m MSL). The garden spans an area of 2,196 square meters, characterized by a semi-arid climate. Jamnagar experiences an average annual temperature of 26.4°C. Summers are extremely hot, with temperatures reaching up to 40°C, while winters are relatively mild, averaging 11.5°C[2]. Jamnagar is part of a region characterized by significant spatial and temporal rainfall variation, with areas receiving less than 500 mm classified as arid[21], with irregular patterns often leading to droughts or flash floods. Low humidity levels dominate most of the year, except during the monsoon season. Prevailing winds are westerly, occasionally intensifying during cyclonic periods. The botanical garden hosts a variety of flora, with 87 plant species and 6 grass varieties. *Tecoma stans* is one of the dominant species. The abundant vegetation provides a rich habitat for various insect species, supporting pollinators, herbivores, and predators.

The study was done from November 2023 to January 2024, with weekly data collection sessions. To assess insect diversity, a quadrat sampling method was employed. Quadrats measuring 50 x 50 cm were used, and 110 quadrats were placed in a zig-zag pattern within the study area, covering a total of 34 square meters. Field observations took place between 9:00 AM and 3:00 PM, with varying times each week to capture different periods of insect activity. Observations were recorded meticulously in a designated field log. Images of insects were captured using a Redmi Note 7 Pro smartphone, which were then uploaded to the iNaturalist app for species identification. Besides, Plant species were identified with the assistance of a botanist, and a plant checklist was prepared. Microsoft Excel 2016 was used for the statistical analysis of the data, including the calculation of diversity indices such as Simpson's and Shannon-Weiner indices. Metrics like diversity, abundance, density, and frequency were also analyzed.

Diversity Indices : 1. Simpson's Diversity Index (D): This index accounts for both species richness and evenness. The formula is :

$$D = 1 - \{ \Sigma (n - 1) / N (N - 1)\}n$$

Where,

n = the number of organisms of the individual species
N = the total number of individuals of all species

2. Shannon-Weiner Diversity Index (H): This index considers both species richness and evenness, with the formula:

$$H = -\sum_{i=1}^{s} p_i ln (p_i)$$

Where,

H=the Shannon index value

Pi=the proportion of individuals found in the species

ln=the natural logarithm

s=the number of species in the community

Additional Metrics

$$\textbf{Frequency} = \frac{\text{Total no. of quadrate in each species occured (A)}}{\text{Total no. of quadrate studied (B)}} \times 100$$

$$\textbf{Abundance} = \frac{\text{Total no. of individuals in all the quadrate studies (N)}}{\text{Total no. of quadrate in each species occured (A)}} \times 100$$

$$\textbf{Density} = \frac{\text{Total no. of individuals in all the quadrate studies (N)}}{\text{Total no. of quadrate studied (B)}} \times 100$$

Results and Discussion

The diversity of insects and spiders in the Botanical Garden of D.K.V. Arts & Science College, Jamnagar, was assessed using Shannon and Simpson's diversity indices. The monthly diversity data show a fluctuating trend in both indices across the sampling period. Shannon's diversity index (H') ranged from 1.32 to 2.60, indicating moderate to high diversity throughout the study (Table-1). The highest Shannon index value of 2.60 was recorded in January 2024, while the lowest was observed in early December 2023. Similarly, Simpson's diversity index (D) varied between 0.60 and 0.87, suggesting a consistent distribution of species across most months (Table-1). The peak in Simpson's index in January 2024 aligned with the highest recorded species diversity. The gradual increase in both diversity indices in January 2024 reflects a potentially favorable environmental condition for species richness and evenness during that month. The high Shannon diversity index in the end of January coincides with a wide distribution of various insect families, as observed in the collected samples. However, in a study conducted at Khijadiya bird Sanctuary, observed less insect activities during winter[3]. Arthropods are seasonal and mature individuals are found only for few months after rains[4]. Areas with high humidity and mixed forest harbour more diversity of arthropods[4]. Besides, A notable increase in insect diversity was observed between 10:00 AM to 11:00 AM in January.

A total of 88 species, comprising both insects and spiders, were recorded during the survey. Of these, 42 genera across 38 families were identified. Additionally, 18 species were identified to the species level, representing both insect and spider classes. The insect community was represented by 7 different orders, categorized into 31 families and 35 genera. Among these, 17 insect species were identified up to the species level.

Based on the data collected, the order Hymenoptera was well represented, particularly by the family Formicidae (ants), which contributed significantly to the overall insect community in terms of abundance, density, and frequency. Formicidae species accounted for 62.42% of the abundance, 82.62% of the density, and 54.67% of the frequency (Fig.-1, Table-2). Notable species in this family include *Camponotus compressus*, *Tetraponera rufonigra*, *Paratrechina longicornis*, *Tapinoma melanocephalum*, *Pheidole sp.*, and *Trichomyrmex destructor* (Table-2). This dominance highlights the critical ecological roles ants play within the garden ecosystem. Other Hymenoptera families were observed in smaller proportions. The Apidae family, represented by species *Ceratina sp.* and *Xylocopa sp.*, contributed 0.63% to abundance, 0.24% to density, and 0.67% to frequency (Fig.-1). The Braconidae family, represented by *Phanerotoma sp.*, and Crabronidae, represented by *Carinostimus sp.*, each contributed 0.32% to abundance, 0.12% to density, with Braconidae reaching a frequency of 0.33% and Crabronidae a frequency of 0.67%. Lastly, an unidentified species from the family Termitoidae made up 0.32% of the abundance, 0.12% of the density, and 0.33% of the frequency. This dominance suggests the significant ecological role ants play, particularly in soil turnover and serving as prey for other animals. The prevalence of ants in Khijadiya, linking their presence to increased floral diversity[3].

In the Lepidoptera order, the family Erebidae, represented by *Amata passalis*, showed the highest abundance (1.58%), density (0.71%), and frequency (2%). Other notable species included *Danaus chrysippus* from the Nymphalidae family, *Catopsilia pomona* from Pieridae, and *Papilio polytes* and *Papilio demoleus* from Papilionidae (Table-2). The Papilionidae family recorded an abundance of 0.63%, density of 0.24%, and frequency of 0.67%, while the Pieridae family had an abundance of 0.32%, density of 0.12%, and frequency of 0.33%. The presence of these species highlights the diversity of butterflies in the Lepidoptera order within the garden, contributing to its ecological balance and pollination activities.

In the order Diptera, various families were recorded, each with distinct abundance, density, and frequency values. The Dolichopodidae family, represented by the species *Chrysosoma leucopogon*, exhibited an abundance of 0.32%, a density of 0.12%, and a frequency of 0.33%, indicating moderate occurrence within the observed dataset. The Muscidae family was represented by *Stomoxys* sp., although specific values for its abundance, density, and frequency were not recorded in this study.

The Tachinidae family, represented by *Mintho* sp., showed the highest values among the recorded families, with an abundance of 0.53%, a density of 0.59%, and a

TABLE-2 : Checklist of Spiders (Aranae) and Insects recorded during the study

Order	Family	Genera	Species Name
Araneae	Araneidae	*Eriovixia*	*Eriovixia excelsa*
	Gnaphosidae		
	Lycosidae		
	Oxyopidae	*Oxyopes*	*Oxyopes sp.*
	Salticidae	*Harmochirus*	*Harmochirus sp.*
	Theridiidae	*Asagena*	*Asagena sp.*
		Emertonella	Emertonella taczanowskii
	Thomisidae	*Xysticus*	*Xysticus sp.*
		Tmarus	Tmarus sp.
Blattodea	Blattellidae	*Blattella*	*Blattella sp.*
Coleoptera	Carabidae	*Harpalus*	*Harpalus sp.*
	Coccinellidae	*Brumoides*	*Brumoides suturalis*
	Tenebrionidae		
Diptera	Dolichopodidae	*Chrysosoma*	*Chrysosoma leucopogon*
	Muscidae	*Stomoxys*	*Stomoxys sp.*
	Tachinidae	*Mintho*	*Mintho sp.*
	Tephritidae	*Dacus*	*Dacus sp.*
	Aphididae		
	Berytidae		
	Cydnidae		
	Dictyopharidae		
	Lygaeidae	*Graptostethus*	*Graptostethus sp.*
		Aspilocoryphus	Aspilocoryphus sp.
		Melanotelus	Melanotelus sp.
	Membracidae	*Leptocentrus*	*Leptocentrus sp.*
	Pentatomidae	*Eysarcoris*	*Eysarcoris guttigerus*
		Adria	Adria parvula
	Plataspidae		
	Rhyparochromidae	*Elasmolomus*	*Elasmolomus squalidus*
		Poeantius	Poeantius sp.

Order	Family	Genera	Species Name
Hymenoptera	Formicidae	*Camponotus*	*Camponotus compressus*
	Apidae	*Ceratina sp.*	*Ceratina sp.*
		Xylocopa	Xylocopa sp.
	Braconidae	*Phanerotoma*	*Phanerotoma sp.*
	Crabronidae	*Carinostimus*	*Carinostimus sp.*
	Formicidae	*Tetraponera*	*Tetraponera rufonigra*
		Paratrechina	Paratrechina longicornis
		Tapinoma	Tapinoma melanocephalum
		Pheidole	Pheidole sp.
		Trichomyrmex	Trichomyrmex destructor
	Termitoidae		
Lepidoptera	Erebidae	*Amata*	*Amata passalis*
	Nymphalidae	*Danaus*	*Danaus chrysippus*
	Papilionidae	*Papilio*	*Papilio polytes*
			Papilio demoleus
	Pieridae	*Catopsilia*	*Catopsilia pomona*
Mantodea	Mantidae	*Tenodera*	*Tenodera sp.*
Orthoptera	Acrididae	*Spathosternum*	*Spathosternum prasiniferum*
		Trilophidia	Trilophidia annulata
		Catantops	Catantops sp.
		Eritettix	Eritettix sp.
	Pyrgomorphidae		
	Trigonidiidae	*Trigonidium*	*Trigonidium sp.*

frequency of 1. This suggests that Tachinidae was the most consistently observed family within the Diptera order in the study area. Similarly, the Tephritidae family, represented by *Dacus* sp., recorded an abundance of 0.32%, a density of 0.12%, and a frequency of 0.33%, showing comparable occurrence to Dolichopodidae but with lower overall values than Tachinidae(Fig.-1) .

An unidentified family was also noted, though it could not be classified in terms of abundance, density, or frequency. Overall, the results indicate that Tachinidae had the highest frequency and density within Diptera, while Dolichopodidae and Tephritidae showed similar, though lower, values. This distribution highlights the relative prominence of Tachinidae in the observed

ecosystem compared to other families within the order.

In the order Blattodea, family Blattellidae was represented by *Blattella sp.* and an unidentified species. The family Blattellidae demonstrated an abundance of 4.48%, a density of 3.78%, and a frequency of 7.67%. In the order Orthoptera, three families were identified: Acrididae, Pyrgomorphidae, and Trigonidiidae. The family Acrididae, represented by species such as *Spathosternum prasiniferum*, *Trilophidia annulata*, *Catantops sp.*, and *Eritettix sp.*, had the highest presence, with an abundance of 2.85%, a density of 1.06%, and a frequency of 3% (Fig.-1, Table-2). The family Pyrgomorphidae included unidentified species, showing an abundance of 0.63%, a density of 0.24%, and a frequency of 0.67%. Additionally, the family Trigonidiidae was represented by *Trigonidium sp.*, with an abundance of 0.32%, a density of 0.12%, and a frequency of 0.33% (Fig.1).

In the order Hemiptera, a variety of families were documented, including Lygaeidae, Rhyparochromidae, Aphididae, Berytidae, Cydnidae, Dictyopharidae, Membracidae, Pentatomidae, and Plataspidae. Within Lygaeidae, species such as *Graptostethus sp.*, *Aspilocoryphus sp.*, and *Melanotelus sp.* were observed. The family Rhyparochromidae included species like *Elasmolomus squalidus* and *Poeantius sp.*, along with unidentified members.

Quantitatively, the family Aphididae showed an abundance of 1.26%, density of 0.47%, and frequency of 1.33%, while Lygaeidae had the same values, highlighting their similar distribution. Berytidae and Cydnidae each exhibited 0.63% abundance, 0.24% density, and 0.67% frequency (Fig. 1). Membracidae and Plataspidae recorded an abundance of 0.32%, density of 0.12%, and frequency of 0.33% (Fig.1). Pentatomidae and Rhyparochromidae were more prevalent, with 1.58% abundance, 0.59% density, and 1.67% frequency each. Other observed species included *Eysarcoris guttigerus* and *Adria parvula* within Pentatomidae, *Leptocentrus sp.* from Membracidae, and unidentified species across various families, contributing to the diversity recorded within Hemiptera (Table-2).

In the order Coleoptera, three families were identified: Tenebrionidae, Coccinellidae, and Carabidae. The family Tenebrionidae included unidentified species and showed the highest abundance, density, and frequency within this order, with values of 1.58%, 0.71%, and 2%, respectively (Fig.1). In Coccinellidae, *Brumoides suturalis* was recorded, with an abundance of 0.32%, density of 0.12%, and frequency of 0.33% (Fig.1). The Carabidae family, represented by *Harpalus sp.*, exhibited similar values for abundance, density, and frequency as Coccinellidae, also at 0.32%, 0.12%, and 0.33%, respectively (Fig.-1). These observations highlight the distribution of Coleopteran families within the surveyed area, with Tenebrionidae showing greater prevalence compared to the other families. The family Carabidae is well-known both taxonomically and ecologically, often used in indicator studies due to its sensitivity to habitat changes. While most species are carnivorous, some are herbivorous[3].

Within the order Mantodea, the family Mantidae was represented by the genus *Tenodera*. This genus recorded an abundance of 0.32%, a density of 0.12%, and a frequency of 0.33% in the study area (Fig.1). These values indicate a relatively low occurrence of Mantidae within the surveyed insect population, suggesting that *Tenodera* species are present but not highly prevalent in the area. This group is known for its camouflage abilities, and its occurrence mainly noticed during winter when prey is most abundant[3].

The survey also recorded 21 species of spiders (Araneae) belonging to 7 families, with notable representation from Thomisidae, Oxyopidae, Salticidae, Theridiidae, Gnaphosidae, Lycosidae, and Araneidae. The family Oxyopidae, represented by *Oxyopes* sp., exhibited the highest abundance and frequency among the spider families, with an abundance of 2.21%, density of 1.3%, and frequency of 3.67%, indicating a significant presence in the surveyed area (Fig.1). Thomisidae, identified by genera such as *Xysticus* and *Tmarus*, showed an abundance of 1.26%, density of 0.47%, and frequency of 1.33%. Salticidae, represented by *Harmochirus* sp. and several unidentified species, also had an abundance of 1.26%, density of 0.47%, and frequency of 1.33% (Fig.1). The family Theridiidae, which included *Asagena* sp. and *Emertonella taczanowskii*, showed a moderate abundance of 0.95%, density of 0.35%, and frequency of 1.00%. Gnaphosidae and Lycosidae were less prevalent, with Gnaphosidae showing an abundance of 0.63%, density of 0.24%, and frequency of 0.67%, while Lycosidae exhibited lower values with an abundance of 0.32%, density of 0.12%, and frequency of 0.33%. Finally, Araneidae, represented by *Eriovixia excelsa* contributed 0.63% to abundance, 0.24% to density, and 0.67% to frequency (Fig.1). These findings highlight the diversity of spider families in the study area, with Oxyopidae being the most prominent group. Several species of jumping spiders were also observed but remained unidentified, indicating the need for further taxonomic work.

Two species from the family Theridiidae were identified, namely *Asagena sp.* and *Emertonella taczanowskii*. *Emertonella taczanowskii* has been

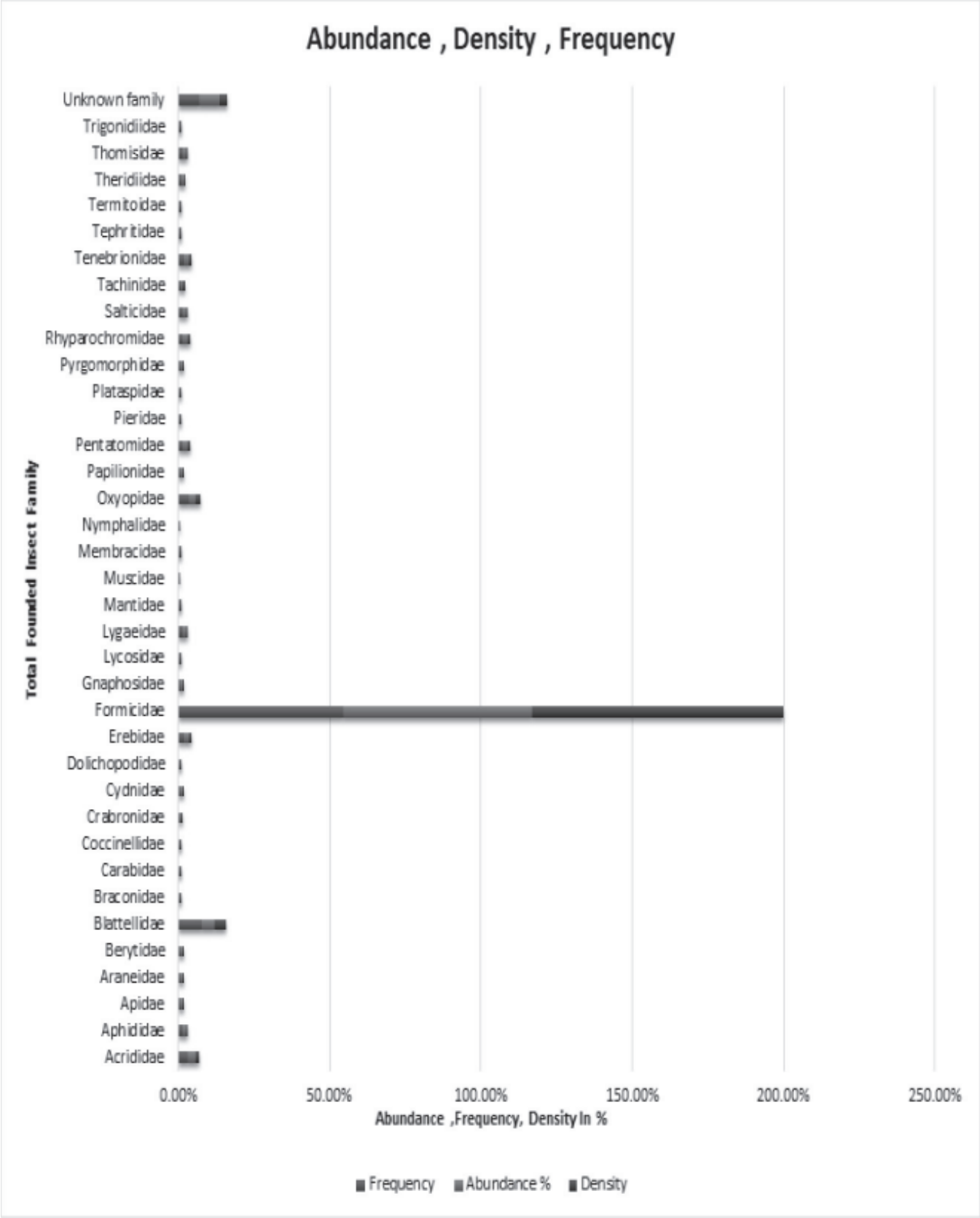

Fig. 1 : Abundance, density and frequency distribution of ijnsect families recorded in the study area

reported for the first time in Jamnagar, Gujarat, as not reported previously from Gujarat. However, a significant number of spiders remain unidentified at both the genus and species levels, indicating the need for further

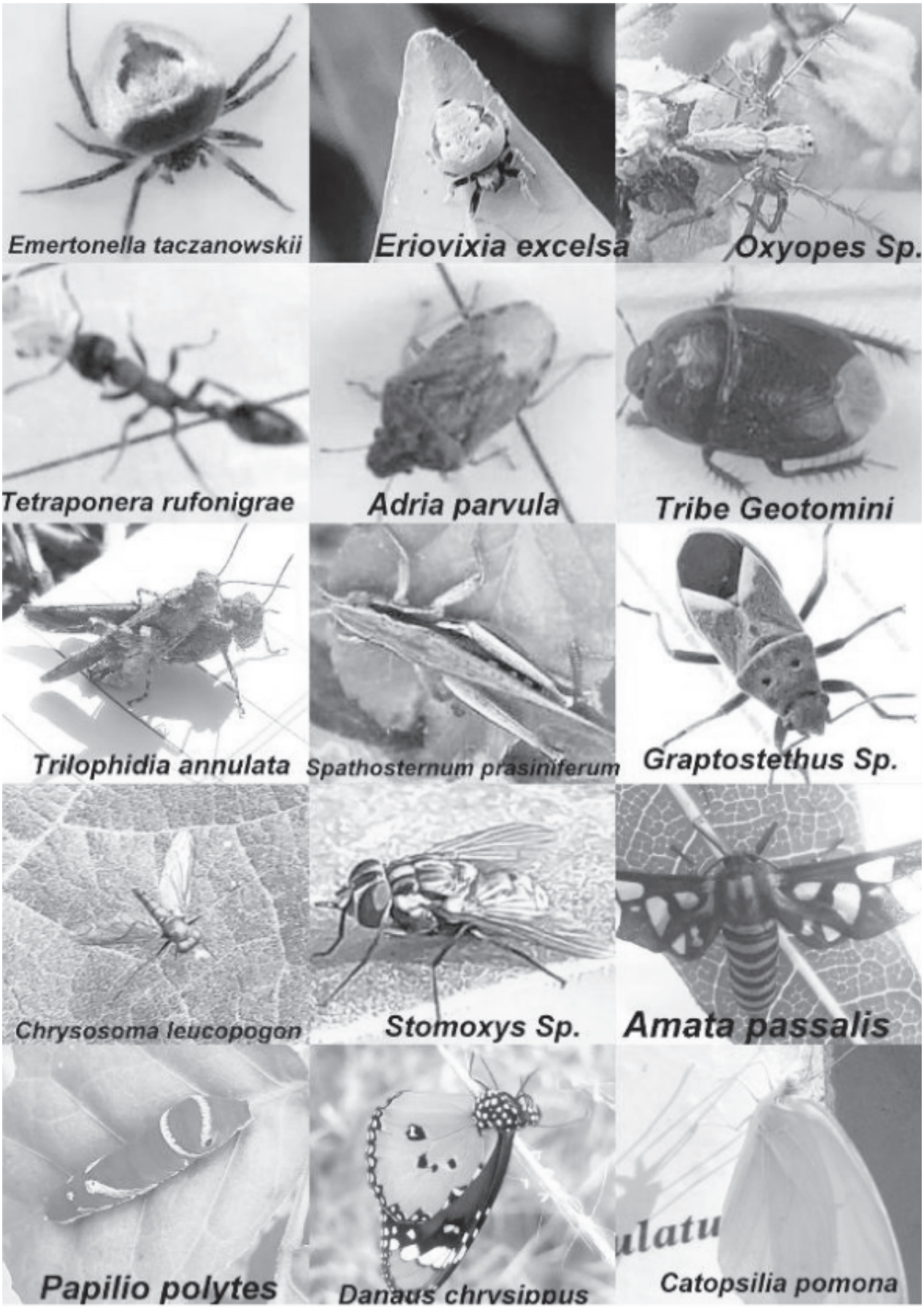

Fig. 2 : Insects and Spider species observed during the study period at Botanical Garden of D K V Arts & Science college Jamnagar, Gujarat, India.

taxonomic study.

In insects, the family Formicidae (ants) was the most represented, with 6 species across 6 genera. In spiders, Salticidae was the dominant family, with 5 species recorded, although many remained unidentified at the genus level. However, A substantial number of species remain unidentified, particularly in the orders Hemiptera and Araneae as images were taken through smartphone in the field it was limitation to identify species up to species level. This highlights the biodiversity in the area and the necessity of more in-depth taxonomic efforts to identify and classify these organisms.

The garden's flora diversity, with 87 plant species from families like Meliaceae, Papilionaceae, and Myrtaceae, also played a significant role in supporting the insect population. The interaction between insect species and plant species such as *Azadirachta indica* (Meliaceae) and *Terminalia catapa* (Combretaceae) suggests a complex ecological relationship that enhances biodiversity within the garden. The diversity and density of insects are likely influenced by the availability of resources provided by these plant species, contributing to the overall ecological health of the garden. This preliminary study provides insight into the rich diversity of insects and spiders inhabiting the Botanical Garden. The data reveal high species diversity, with many species remaining to be identified. This calls for future research to further classify unidentified species and explore their ecological significance.

Conclusion

This study highlights the rich diversity of insects and spiders in the Botanical Garden of D.K.V. Arts & Science College, Jamnagar, with a total of 88 species observed, including ants (Formicidae) as the dominant insect family and Oxyopidae as the most prominent spider family. Diversity indices (Shannon and Simpson) indicated moderate to high diversity, peaking in January 2024, likely due to favorable conditions that month. The garden's 87 plant species provide essential resources, supporting a balanced ecosystem with complex interactions, especially between insects and plant species like *Azadirachta indica* and *Terminalia catapa*. While this survey reveals significant biodiversity, limitations in species identification suggest a need for further taxonomic research to explore the ecological roles of these organisms fully.

References

1. Ahir KM. Distribution and Biology of Arthropods in Gir Protected Area and its surrounding Ecosystem With special reference to Insects: Coleopetra. Ph.D. Thesis. Maharaja Sayajirao University, Baroda 2005.
2. Indianclimate.com. (n.d.). *Indian Climate - Temperature data of Jamnagar*. https://www.indianclimate.com/ambient-temperature-data.php?request=JNNOVS4OEQ#:~:text=The%20average%20 Temperature%20of%20Jamnagar, C%20to%2030.2%C2%B0C.
3. Jethva B, Dave C, Ahir K, Parasharya D, Gadhvi M, Sharma JK. Faunal Biodiversity Survey for Baseline Assessment of Khijadiya Wildlife Sanctuary in Gujarat. *Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH Indo-German Biodiversity Programme (IGBP), GIZ-India.*2017; CMPA Technical Report Series No. 33.
4. Kumar D. Documentation of Biodiversity of Arachnida and Lepidoptera (Phylum Arthropoda) within Gujarat Final Report – Phase I (2013-2014). Gujarat Biodiversity Board Gandhinagar.
5. Landmann T, Schmitt M, Ekim B, Villinger J, Ashiono F, Mabel JC, Tonnang HEZ. Insect diversity is a good indicator of biodiversity status in Africa. *Commun Earth Environ.* 2023; **4**: 234. https://doi.org/10.1038/s43247-023-00896-1.
6. Pandit R, Pai IK. Spiders of Taleigao Plateau, Goa, India. *J. Environ. Sci. Public Health*. 2017; **1** (4): 240-252.
7. Patel BH. Spiders of Vansda National Park, Gujarat. *Zoos' Print J*. 2003; **18** (4): 1079-1083.
8. Patel SB, Bhatt NB, Patel KB. Diversity of spider fauna of Ratanmahal Sloth Bear Sanctuary, Gujarat. *Life Sci. Leafl.* 2012; **7**: 74-79.
9. Prajapati DA, Patel KR, Munjpara SB, Chettiar SS, Jhala DD. Spiders (Arachnida: Araneae) of Gujarat University Campus, Ahmedabad, India with additional description of Eilica tikaderi (Platnick, 1976). *J. Threat. Taxa.* 2016; **8** (11): 9327-9333.
10. Prakhar P, Singh M, Agrawal RK. A Study of Insect Diversity in Different Habitats Found in Nearby Locality of Raipur, Chhattisgarh. *Int. J. Sci. Res. Sci. Technol.* 2021; **8** (5): 467-468.

11. Sanetra D, Johanna L, Hartlieb BM, Nadja K, Walther SG, Blüthgen N, Staab M. Disentangling how urbanisation influences moth diversity in grasslands. Insect Conserv. Divers. 2024. doi: 10.1111/icad.12713.

12. Schowalter TD. Insect ecology an ecosystem approach, fourth edition. Academic Press of Elsevier, London. 2016; 1-136. ISBN: 978-0-12-803033-2.

13. Shah A, Parikh P. A Survey of Insect Diversity in Gujarat. *J. Entomol. Res*. 2015; **39**(4): 321-335.

14. Shannon CE, Weaver W. The mathematical theory of communication. Urbana: University of Illinois Press; 1963.

15. Shannon CE. A mathematical theory of communication. *Bell Syst. Tech. J.* 1948; **27**: pp. 379-423.https://doi.org/10.1002/j.1538-7305.1948.tb01338.x

16. Sharma S, Sharma S, Sharma R. Impact of land use change on insect diversity: A review. *Int. J. Curr. Microbiol. Appl. Sci.* 2019; 8(8): 1151-1160.

17. Shukla R, Trivedi J. Insect Fauna of Gir Forest National Park: An Overview. *Indian J. For.* 2017; **40**(2): 183-194.

18. Siliwal M, Suresh B, Pilo B. Spiders of Purna Wildlife Sanctuary, Dangs, Gujarat. *Zoos' Print J*. 2003; **18** (11): 1259-1263

19. Simpson EH. Measurement of diversity. *Nature.* 1949; **163**: pp. 688. doi:10.1038/163688a0.

20. Tikader BK. Handbook, Indian Spiders. *Zoological Survey of India*. 1987; p. 251.

21. Vaidya VB, Dhabale S, Damle KS, Chimote LD, Kulshreshtha MS. Astro-Meteorological Rainfall Prediction and Validation for Monsoon 2018 in Gujarat, India. *Int. J. Curr. Microbiol. Appl. Sci.* 2019; **8**(5) : 2359-2370. doi: 10.20546/IJCMAS.2019.805.279

22. Yadav A, Solanki R, Siliwal M, Kumar D. Spiders of Gujarat: a preliminary checklist. *J. Threat. Taxa.* 2017; **9**(9): 10697-10716.