

## Preliminary survey of butterfly diversity and abundance at Saurashtra University Campus, Rajkot, Gujarat, India

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### Abstract

A study was conducted on the diversity and abundance of butterflies at Saurashtra University Campus. Butterflies, belonging to the order Lepidoptera, are key pollinators and climate change indicators. There are over 28,000 species globally, with 80% in tropical regions. The present study was conducted for eight months from July 2023 to February 2024. We conducted field visits twice a month. The observation was made in the morning and Evening timing. Different diversity indices were analyzed and calculated separately. In Butterfly diversity, a total of 1943 individuals of butterflies from 37 species and 28 Genera belong to 5 families. The highest number of species was recorded from the family Pieridae, followed by Lycaenidae, Nymphalidae, Papilionidae, and Hesperidae. The family Lycaenidae had the highest diversity with 13(35.13%) species followed by Nymphalidae 11(29.72%), Pieridae 8(22.66%), Papilionidae 3 (8.10%), and the Hesperidae least Diversity with 2(5.40%). Simpson's index is 0.139 so, it concluded that the higher diversity in this study area. Margalef's index is 4.755 which indicates greater species richness within the community. The study confirms high butterfly diversity across seasons, highlighting the site's potential for butterfly preservation and conservation of their host species in natural habitats.

**Keywords:** Butterfly, Saurashtra University Campus, diversity, richness, diversity indices

### Introduction

Butterflies are beautiful insects that belong to the order Lepidoptera of Phylum Arthropoda. This is the largest phylum on Earth. The name of a butterfly comes from the Greek words Lepidoptera, lepido "Scale" and Ptera "wings" of the class Insecta. Butterfly wing scales are made up of chitin and give beautiful color and pattern making them one or more familiar of all insect groups. It also supports human society economically and ecologically. Butterflies are pollinators and act as nature's messengers. They also serve as indicators of climate change within ecosystems.

Butterflies have a fascinating history that spans millions of years. Fossil evidence suggests they existed around 40-50 million years ago. Over time, they evolved from moths, developing distinct features like colorful wings and a more delicate body structure. Butterflies have played symbolic roles in various cultures, representing transformation and beauty. Butterflies have been recorded in fossils dating back to the mid-Eocene epoch, around 200 million years ago in ancient Egypt<sup>[20]</sup>. Studying butterflies has a long and interesting history.

Butterflies and larvae depend on food plants and nectar that is produced in flowering plants, which is crucial for their survival<sup>[12]</sup>. Most butterflies are only around during certain seasons, and they prefer only a particular habitat.

There are more than 28,000 species of butterfly worldwide, with roughly 80% of them found in tropical areas<sup>[07,23]</sup>. A total of 193 butterfly species are present in Gujarat State<sup>[14]</sup>. Very scattered information is available from Gujarat presently 79 species in South Gujarat. 78 Species from Central Gujrat (Kathiawar)<sup>[11]</sup>.

Butterflies exhibit a higher degree of diversity in tropical regions compared to temperate zones,<sup>[16]</sup>. The species richness and diversity depend on the availability of larval plants for food and adequate nectar resources. Variations among butterfly types are based on wing size, color, design, and shape. Furthermore, males and females can be

differentiated by their respective wing color patterns and designs. Butterfly activity occurs mostly during daylight hours when their wings are typically closed.

In the past century, many researchers carried out studies on the life cycle, ecology, conservation of butterflies in various habitats, importance, and factors that affect the butterfly. Diversity provides important data for future ecological and conservation research. This study provides abundance, richness, and evenness of butterfly diversity. Butterflies are ideal models for studies, environmental evaluation, population dynamics, and community ecology<sup>[9, 18]</sup>.

The conservation of butterfly diversity is achieved by butterfly gardening, habitat restoration, and enhancement of vegetation in the habitat, urban landscaping increases the population of butterflies by modifying in existing environment manually Gandhi & Kumar, (2016). Conservation is necessary to sustain varied kinds of ecosystem services for human well-being<sup>[21]</sup>.

These studies provided important data for future ecological and conservation research and the systematic butterfly diversity indices of butterfly species richness, density, and Species evenness in its selected site of Saurashtra University Campus.

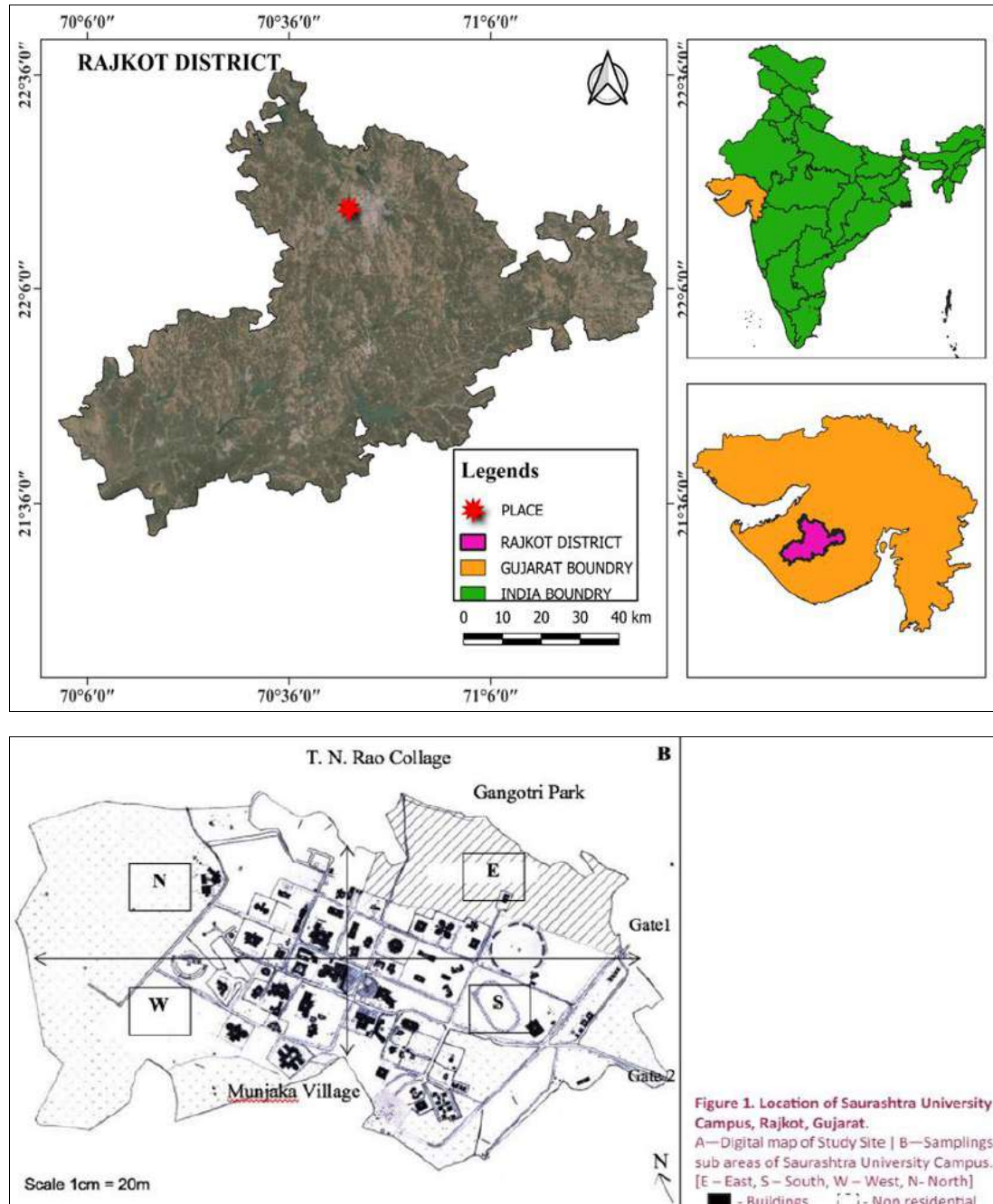
### Materials and method

#### Study area

Saurashtra University Campus (SUC) is situated in Rajkot City (22.291 N, 70.743 E, 140 m) in central Gujarat, State in western India (Fig.1) The Urban campus falls in 363 acres of area. The climate of Rajkot is tropical arid to semi-arid with three distinct seasons each year, monsoon, winter, and summer. The annual rainfall is erratic in its occurrence, duration, and intensity. Annual rainfall was high at 1,311.2mm during 2023; the average temperature varies between 21.5°C and 34.5°C and average humidity ranges between 57.9 and 88.4% (morning) and 17.4 to 80.3% (evening).The ecological overview of all five sections (Lake

area, Botanical Garden area, Sports ground area, Different department area, Miscellaneous (consist of mixed vegetation) of SUC includes the predominant vegetation layer and likely comprises a diverse range of plant species

including native trees, shrubs, grasses, and flowering plants and variety of ornamental plants planted by SU management.



**Fig 1:** The map showing the study area Saurashtra University Campus (SUC), Rajkot

**Data collection**

The present study was conducted for eight months from July 2023 to February 2024. During the study period, we conducted field visits twice a month over Eight months, totaling 16 visits. The observation was made between Morning 9:00 AM to 12:00 PM and Evening 3:00 PM to 6:00 PM. Butterflies were recorded directly in the field by the Pollard Walk method [17]. Line transects were used. The spotting range is 2.5 meters left and right. In each transect, butterflies were observed and taken photographs. Identification of species was done by photographs taken Canon 1100D camera. For identification, the standard identification keys and Reference books, Literature, I Found

Butterfly, I Naturalist, and Photographs were used for accurate identification [06, 27]. Recorded species were categorized under the IUCN Red List [08] and their status in the Wildlife Protection Act (WPA) 1972 of India.

**Status assessment**

The status of butterflies was evaluated and divided into five categories based on the number of sightings during a particular time. The categories are as follows: very common (>100 sightings), C- common (50-99 sightings), NR- not rare (15-49 sightings), R- rare (3-14 sightings), and very rare (1-2 sightings), [24,25], (Table 1).

**Statistical analysis**

Different diversity indices were analyzed and calculated separately like species diversity index, Simpson diversity index (SDI), piелous index (PI) for species evenness, and margalefs diversity index (MDI) for species richness (Table 2).

For the statistical analysis data was divided according to season- monsoon (Jul-Aug), post-monsoon (Sep-Oct-Nov), and winter (Dec-Jan-Feb). The number of species in each family, the total number of species individuals encountered in each family, the overall total number of individuals and month-wise population, and diversity in several species and number of individuals are calculated.

**Result and discussion**

**Species richness**

In the present study, we have recorded a total of 1943 individuals of butterflies from 37 species and 28 Genera that belong to 5 families recorded from the study site. The highest number of Individuals was recorded from the family Pieridae, followed by Lycaenidae, Nymphalidae, Papilionidae, and Hesperidae (Fig. 2). The family Lycaenidae had the highest diversity with 13(35.13%) species followed by Nymphalidae 11(29.72%), Pieridae 8(22.66%), Papilionidae 3 (8.10%), and the Hesperidae least Diversity with 2(5.40%), (Fig. 2) (Fig. 3).

**Table: 1** Checklist of butterflies with family, Common name, Scientific name, Status, and IUCN Category (International Union Conservation of Nature)

No.	Common name	Scientific Name	IUCN	Status
<b>A. Family : Papilionidae</b>				
1	Common Rose	<i>Pachliopta aristolochiae</i> (Fabricius 1775)	LC	R
2	Common Mormon	<i>Papilio polytes</i> (Linnaeus 1758)	NE	R
3	Lime Swallowtail	<i>Papilio demoleus</i> (Linnaeus 1758)	NE	NR
<b>B. Family: Pieridae</b>				
4	Common Emigrant	<i>Catopsilia pomona</i> (Fabricius 1775)	NE	VC
5	Mottled Emigrant	<i>Catopsilia pyracantha</i> (Linnaeus 1758)	NE	VC
6	Small Grass Yellow	<i>Eurema brigitta</i> (Stoll 1780)	LC	R
7	Spotless Grass Yellow	<i>Eurema laeta</i> (Boisduval 1836)	NE	VC
8	Common Grass Yellow	<i>Eurema hecabe</i> (Linnaeus 1758)	LC	VC
9	Pioneer	<i>Belenois aurota</i> (Fabricius 1793)	LC	R
10	Large Salmon Arab	<i>Colotis fausta</i> (Oliver 1804)	LC	R
11	Small Salmon Arab	<i>Colotis amata</i> (Fabricius 1775)	NE	R
<b>C. Family: Nymphalidae</b>				
12	Angeled Castor	<i>Ariadne ariadne</i> (Linnaeus 1763)	NE	R
13	Blue Pansy	<i>Junonia orithya</i> (Linnaeus 1758)	LC	R
14	Dark Blue Pansy	<i>Junonia oenone</i> (Linnaeus 1758)	LC	VR
15	Lemon Pansy	<i>Junonia lemonias</i> (Linnaeus 1758)	NE	R
16	Danaid Eggfly	<i>Hypolimnas misippus</i> (Linnaeus 1758)	LC	R
17	Great Eggfly	<i>Hypolimnas bolina</i> (Linnaeus 1758)	NE	VR
18	Plain Tiger	<i>Danaus chrysippus</i> (Linnaeus 1758)	LC	VC
19	Tawny Coster	<i>Acraea terpsichore</i> (Linnaeus 1758)	NE	R
20	Black Rajah	<i>Charaxes solon</i> (Fabricius 1793)	NE	VR
21	Painted Lady	<i>Vanessa cardui</i> (Linnaeus 1758)	LC	VR
22	Common Three Ring	<i>Yapthima Asterope</i> (Klug 1832)	NE	R
<b>D. Family :Lycaenidae</b>				
23	Lime Blue	<i>Chilades lajus</i> (Stoll 1780)	NE	R
24	Gram Blue	<i>Eucharysops cnejus</i> (Fabricius 1798)	NE	R
25	Dark Grass Blue	<i>Zizeeria karsandra</i> (Moore 1865)	LC	NR
26	Lesser Grass Blue	<i>Zizina Otis</i> (Fabricius 1787)	LC	R
27	Forget Me Not	<i>Catochrysops strabo</i> (Fabricius 1793)	NE	NR
28	Bright Babul Blue	<i>Azonus ulbadus</i> (Stoll 1782)	LC	VR
<b>NO.</b>	<b>Common Name</b>	<b>Scientific Name</b>	<b>IUCN</b>	<b>Status</b>
29	Striped Pierrot	<i>Tarcus nara</i> (Kollar 1848)	NE	VC
30	Zebra Blue	<i>Leptotes plinius</i> (Fabricius 1793)	NE	R
31	Tiny Grass Blue	<i>Zizula hylax</i> (Fabricius 1775)	LC	C
32	Tailless Line Blue	<i>Prosotas dubiosa</i> (Semper 1879)	NE	R
33	Small Grass Jewel	<i>Freyeria putli</i> (Freyer 1845)	NE	NR
34	Rmon Blue	<i>Hemiargus ramon</i> (Dognin 1818)	NE	R
35	Ceranus Blue	<i>Hemiargus ceranus</i> (Fabricius 1793)	NE	NR
<b>E. Family: Hesperidae</b>				
36	Rice Swift	<i>Borbo cinnara</i> (Wallace 1866)	NE	VR
37	Common Banded Awl	<i>Hasora chromus</i> (Cramer 1780)	NE	VR

The status of Butterflies indicates **VC**- Very Common, **C**- Common, **NR**- Not Rare, **R**- Rare, and **VR**- Very Rare. IUCN Red List indicates **LC**- Least Concern, **NE** (Not Evaluated).

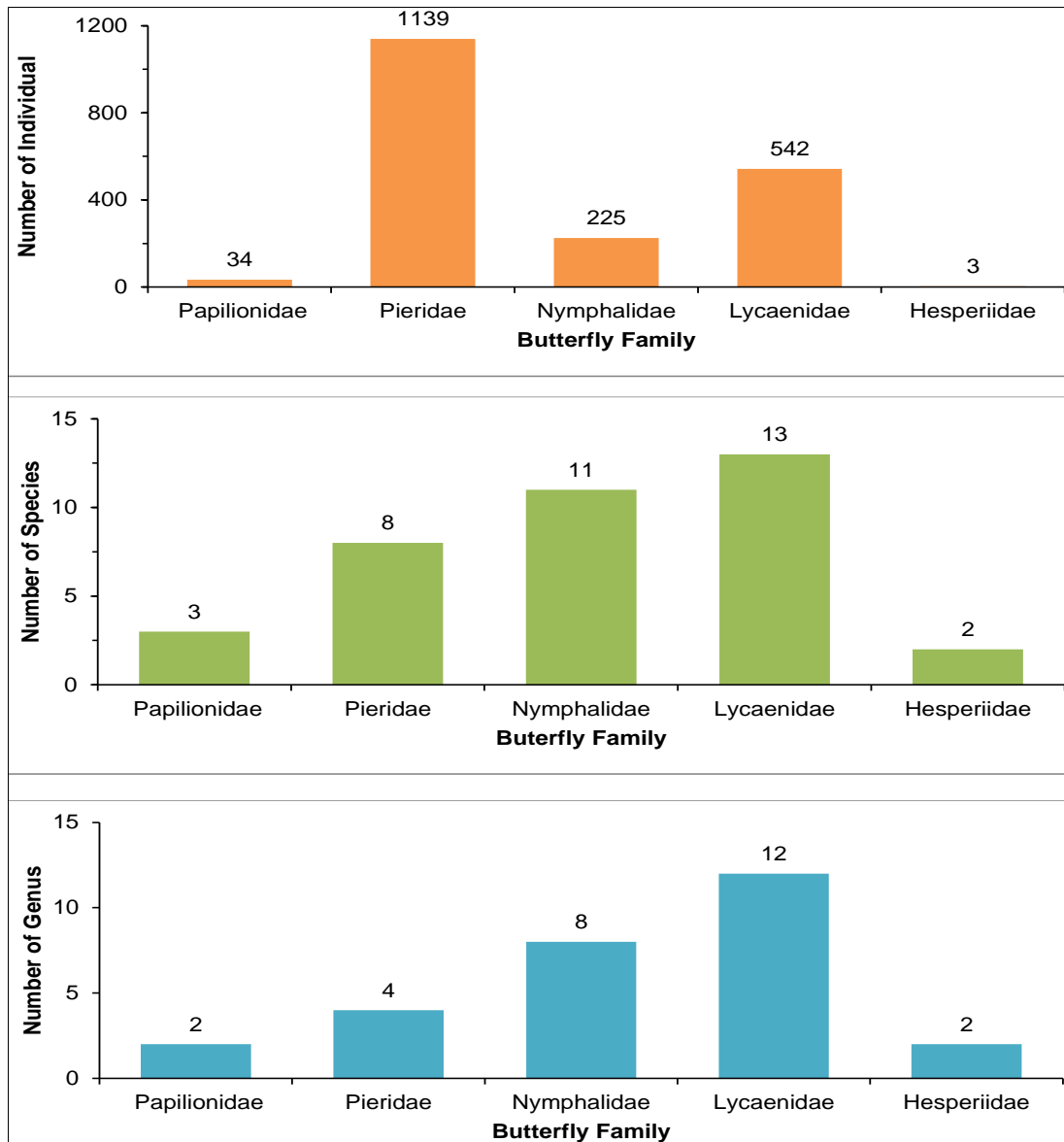


Fig 2: Familial number of individual, genus and species of butterfly

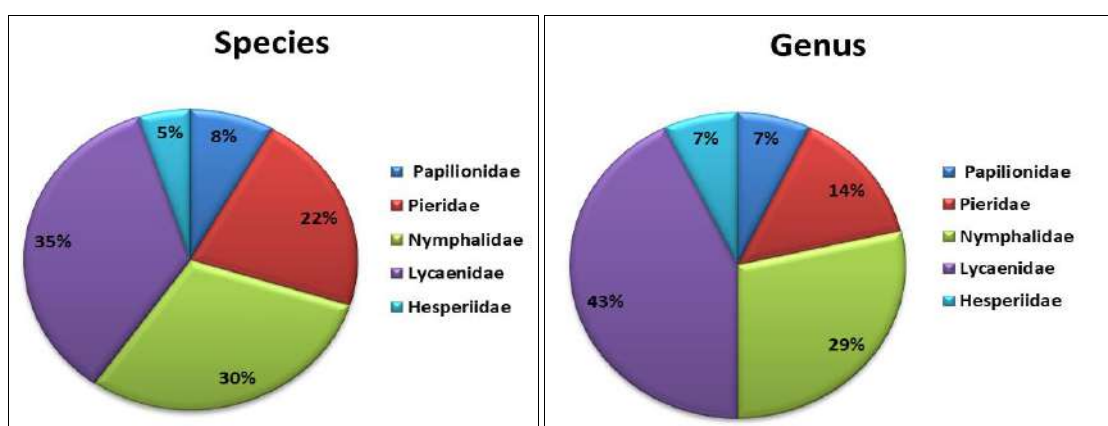


Fig 3: Species and genus percentage of butterflies study site

**Threat status**

In the present study, 14 Species out of 37 were categorized as LC - Least Concern under IUCN [08], red list Index, Common Rose, (*Pachiliopta aristlochaie*), Small Grass Yellow (*Eurema brigitta*), Common Grass Yellow (*Eurema hecabe*), Pioneer (*Belenois aurota*), Large Salmon Arab (*Colotis fausta*), Blue pansy (*Junonia orithya*), Dark Blue

Pancy (*Junonia none*), Danaid Eggfly (*Hypolimonas missippus*), Plain Tiger (*Danaus chrisippus*), Painted lady (*Vanessa cardui*), Dark Grass Blue (*Zizeeria karsandra*), Lesser Grass Blue (*Zizina otis*), Bright Babul Blue (*Azanus ulbadus*), Tiny Grass Blue (*Zizula hylax*) while 23 Species remained unranked in IUCN red list index (Table 1).

### Status assessment

For the status of butterflies, we analyzed that about 6 species were recorded under Very Common status, 1 species under Common status, 5 species under Not Rare, 18 species under Rare status, and 7 species under Very Rare Status (Table 1).

### Month-wise population of butterflies

During the study period from July 2023 to February 2024. The maximum population of butterflies was recorded in August (574), followed by September (445), and the minimum population in the month was recorded in February (47). Whereas maximum species in August (28 species) and minimum in February (12 Species). It is possible due to medium temperature (26 to 32°C), wet climate, and humidity increase in August, and September. This may help to establish the vegetation layers and availability of food resources support for their breeding.

### Species density

A total of 1943 individuals of butterflies and 37 species of a total of 16 visits to the sampling site. The species density is moderate with a value of 2.31 species per visit during the entire study period. The population density is 121.43 individuals per visit.

Simpson's index D is 0.139 so, it concluded that the higher diversity in this study area. Simpson Index of Diversity is (0.86), The butterfly species recorded from study sites had a Greater Value of the Simpson Index of Diversity indicating directly propositional to Greater diversity of any species. The Shannon-wiener index ( $H'$ ) value is (2.31) the number of species present in each of the five families is considered as the species richness [13]. Pielou's index (J) was used in calculating species evenness. J is near to 0.745. It increases with a decrease in stress, clear that this study site has less stress element. Species are evenly distributed in this area. Margalef's index (d) is 4.755, indicating greater species richness within the community and its sample size. Index value increases as community richness and Evenness increase [10], (Table 2).

**Table 2:** Ecological indices of butterflies at Saurashtra University Campus, Rajkot

Sr.No.	Statistical Analysis	Value
1	Total visit (v)	16
2	Total no. of Individuals	1943
3	Total no. of Species (S)	37
4	Species Density (S/v)	2.31
5	Population Density (n/v)	121.43
6	Simpson's Index(D)	0.13908
7	Simpson's Index of Diversity(1-D)	0.86092
8	Simpson's Reciprocal Index (1/D)	7.194
9	Shannon Weiner Index ( $H'$ )	2.315
10	Evenness Index (J) by Pielou's (1966)	0.745
11	Species richness (d) by Margalef Index (1973)	4.755

In this study, we observed significant variations in bird diversity, and Similar studies are conducted on the diversity of butterflies of Gujarat such as [05]. Studied butterfly diversity of the Wadhvana irrigation reservoir in Vadodara. She recorded a total of 42 species belonging to 4 families. [22] Reported a total of 24 species of butterfly in Sundarvan, Ahmedabad. which belong to five families including Nymphalidae (10), Pieridae (7), Papilionidae (4),

Lycaenidae (2), and Hesperidae (1). [03] Reported 66 species and 44 genera of butterfly in Junagadh. [16] Study on butterflies' diversity in Anand. A total of 84 species of Lepidoptera are distributed in 14 families and 69 genera in Soda Lake, vinegar, and North Gujarat [15]. They found a total of 52 species of butterflies. [04] Studied butterfly diversity in Visnagar, Mehsana District. They reported 40 species of 29 genera belonging to five families. [26] Studied butterfly diversity in Victoria Park in Bhavanagar, a total of 69 Species and 45 genera were recorded in this research for habitat restoration in reserve forests. Some studies from Rajkot district such as heterogeneity of butterflies at Sarapdad, Rajkot, Gujrat, India [19]. During the study, 38 species of butterflies were observed from 5 different families. The most represented family was the Pieridae and the less frequently observed family was Hesperidae. [02] Study on butterfly diversity at Jasdan, Rajkot, India. During this study, a total of 15 species and 04 families were reported. [01] Reported Diversity of Butterflies at Valley of Wildflowers Ishwariya Hill Garden, Madhapar, Rajkot, Gujarat, India. The dominant family found in the area was Pieridae, whereas the dominant genus was found in the family Lycaenidae and Nymphalidae. The maximum species recorded in the family Nymphalidae. The area has varied macro and microhabitats, suitable for different butterfly species.

### Conclusion

The study was conducted from July to February 2024 at the Saurashtra University Campus (SUC) in Rajkot. A total of 1943 individuals, representing 37 species, 28 genera, and five families, were identified at the study site. Among the species of butterfly Maximum population (1139,59%) was recorded in the family Pieridae and the maximum species (13,35%) and Genus (12,43%) were found in the Lycaenidae family.

Species such as very Common Grass Yellow (*Eurema hecabe*) and spotless Grass Yellow (*Eurema laeta*), were sighted most abundantly because of the Grassland ecosystem present. Very Rare Species Dark Blue pansy (*Junonia oenone*), Great Egg fly (*Hypolimona bolina*), Bright Babul Blue (*Azonus ulbadus*), Rice Swift (*Borbo cinara*), Common Banded Awl (*Hasora chromus*), Black Rajah (*Charaxes solon*), Painted Lady (*Vanessa cardui*).

The maximum population (574) and Species (28) of butterflies were found in August, because of favorable conditions for butterflies, and the minimum population (47) and species (12) of butterflies in February. Because butterflies were tolerant of stress.

Species density of Butterflies revealed 2.31 Species were observed in per visit. Where the highest population is in sampling site Saurashtra University Campus, Rajkot. Pielou's index of Species evenness (0.745) indicates that butterfly species were evenly distributed in the ecosystem. Species richness by Margalef's index (4.755), Simpson's index (D=0.139) the low value indicates higher diversity of butterflies, Simpson's index of Diversity (1-D) greater Value of (1-D) is 0.861 indicate greater diversity it represents the probably of two individuals randomly selected from a community that belongs to different species diversity, Simpson's Reciprocal index Diversity (1/D =7.194).

The major of space diversity plays a central role in ecology and conservation biology species diversity index where also the highest simple inside stud site. It reported that there was

a higher diversity in the range of healthy conditions for this site. So, we can conclude that a diverse range of butterflies is distributed across all the seasons making it a potential site for preservation and conservation of butterflies and its host species. This study confirms the butterfly diversity and the potential conservation role of natural habitats. There are many reasons for the increase in butterfly community and through this study it has been concluded that the enhancement and growth of various floral species is in this area the possible reasons for such an increase are due to proper maintenance of trees, caring out suitable plantation programs in treating the whole habitat.

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**Conflict of interest statement**

The authors affirm that there is no conflict of interest associated with this research.

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**Plates**



1. *Pachliopta aristolochiae*



2. *Papilio demoleus*



3. *Papilio polytes*



4. *Catopsilia Pomona*



5. *Catopsilia pyranthe*



6. *Eurema bridge*



7. *Eurema laeta*



8. *Eurema hecabe*



9. *Belenois aurota*



10. *Colotis fauta*



11. *Colotis amata*



12. *Ariadne ariadne*



13. *Junonia orithya*



14. *Junonia Oenone*



15. *Junonia lemonias*



16. *Hypolimonas missipus*



17. *Hypolimonas bolina*



18. *Danaus Crisippus*



19. *Acraea terpsicore*



20. *Charaxe solon*



21. *Vaness cardui*



22. *Yapthima asterope*



23. *Chiladus lajus*



24. *Euchaysops cnejus*



25. *Zizeeria karsandra*



26. *Zizina otis*



27. *Catochrysopus Strabo*



28. *Azanus albadus*



29. *Tarcus nara*



30. *Leptotes plinius*



31. *Zizula hylax*



32. *Protous dubiosa*



33. *Freyeria putli*



34. *Freyeria putli*



35. *Ramon Blue*



36. *Borbo cinara*



37. *Hasora chromus*

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