

# Original Research Article Butterfly Diversity Of Navsari Agricultural University (Nau), Navsari, Gujarat, India

**Aims:** The first systematic attempt to assess and document the butterfly richness on the lush green campus of Navsari Agricultural University (NAU) campus.

**Place and Duration of Study:** The study was conducted at the Navsari Agricultural University (NAU) ~~was and was performed~~ assessed over the duration from September 2020 to December 2022.

**Methodology:** The opportunistic surveys ~~were~~ conducted on a monthly basis in the different pre-determined existing paths on the campus. Butterflies were sighted, identified, and photographed during the surveys. The identification of the species was carried out using field books and later confirmed by photographs taken during ~~each~~ the survey, referencing different available literature ~~traditionally~~ and online ~~databases~~. The species identified were listed and classified into respective families.

**Results:** A total of 83 butterfly species belonging to 5 families were recorded at Navsari Agricultural University (NAU), Navsari, Gujarat between September 2020 to December 2022. 13 butterfly species recorded are protected under scheduled categories of Wildlife protection act, 1972, ~~while~~ 4 species listed under the IUCN red list viz. *Euploea core* under the Least concerned category, *Hypolimnasmisippus* under the Least concerned category, *Junonia almana* under the Least concerned category, and *Castalius rosion* under the vulnerable category, were recorded. ~~Presence of suitable host plants for the butterfly determine the dominance in the campus.~~

**Conclusion:** From this study, it is evident that Navsari Agricultural University (NAU), Navsari, Gujarat has a ~~very rich~~ diverse butterfly fauna.

*Keywords:* Lepidoptera, red list, host plant, Campus

## 1. INTRODUCTION

Butterflies are scaly winged insect of order Lepidoptera along with skippers and moths (Singh, 2011). India harbors 1,501 butterfly species, out of which 334 species are distributed in Western Ghats (Evans, 1932 and Kunte, 2000). Rich local flora influences the butterfly larval host relationship (Murphy and Wilcox, 1986).

Urban green spaces play a crucial role in combating the negative influence of urbanization on local biodiversity. ~~and~~ They are often ~~they end up~~ found in small, fragmented patches like urban parks, Gardens and educational institutes, Agricultural universities, etc., that may be ~~somehow~~ isolated (Kuhn et al., 2022 and Sekarappa and Basavarajappa, 2016). Navsari districts of the southern Gujarat region falls under the northern tip of the Western Ghats with ~~a few~~ studies of butterflies.

Recently ~~very quite a few~~ studies ~~were~~ conducted in urban and semi-urban landscapes of India and Gujarat (Parasharya and Jani, 2007; Bhalodia et al., 2002; Shobana et al., 2012; Tiple, 2012; Kaneria et al., 2013; Kumar, 2013; Arya et al., 2014; Thangapandian et al., 2014; Mali et al., 2014; Gandhi et al., 2015; Priyamvada and Mohapatra, 2016; Gandhi and Kumar, 2016; Mukherjee et al., 2016; Bhatt and Nagar 2017 and Suthar et al., 2019), including in gardens, universities campuses, and urban parks, however, there was no specific work reported in urban landscapes of Navsari district. This is the first systematic attempt to assess and document the butterfly richness ~~of~~ the lush green campus of Navsari Agricultural University (NAU) campus.

## 2. MATERIAL AND METHODS

**2.1 Study area-** The Butterfly's diversity at the Navsari Agricultural University (NAU) was assessed ~~over the duration~~ from September 2020 to December 2022. The university (Lat-20.924660°, Long-72.907953°) sprawls over 3.45 km<sup>2</sup> in the

**Comment [SL1]:** Sorry, but I do not understand the sentence. Do you wish to imply, that all the host plants for the mentioned species were also recorded on the campus, or that the amount of host plants determine how many butterflies of a species were recorded?

Navsari district in Gujarat. This area comes under a heavy rainfall zone northernmost part of the Western Ghats. The unique location of the university allows the diversity of the different species to thrive well.

**2.2 Survey Methods**-The opportunistic surveys were conducted on a monthly basis using the different pre-determined and existing paths on the campus (Kasambe et al., 2018). Butterflies were sighted, identified, and photographed during the surveys using the digital cameras (Canon EOS 3000D and Nikon D7200). The identification of the species was carried out using field books and later confirmed by photographs taken during the surveys, referencing different available literature - traditionally and online (Kunte et al., 2023; Kehimkar, 2016; Kunte, 2000; Gaonkar H., 1996; Varshney and Smetacek, 2015 and Evans, 1932). The species identified were listed and classified into respective families. Along with that occasional rare sightings were also considered while preparing the final checklist. Their status was decided determined according to the number of sightings during the surveys (Priyamvada and Mohapatra, 2016). Butterflies were also classified under the schedule list of India's Wildlife Protection Act, 1972 (Anon., 2006) for a better understanding of conservation strategies.

### 3. RESULTS AND DISCUSSION

A total of 83 butterfly species belonging to 5 families, namely, *Hesperidae* (6 species), *Papilionidae* (6 species), *Pieridae* (20 species), *Lycaenidae* (23 species), and *Nymphalidae* (28 species), were documented during the study period (Table 1, plate i, ii, iii and iv). A total of 13 butterfly species are protected under scheduled categories of wildlife protection act, 1972, i.e. *Castalius rosomonosimon* (Fabricius, 1775) and *Danaus genutiagenutia* (Cramer, [1779]) are under schedule-i, *Hypolimnasmisippus* (Linnaeus, 1764) under schedule i as well as ii, *Anthenelycaeninalycaenina* (r. Felder, 1868), *Ceporanerissaphryne* (Fabricius, 1775), *Charaxes solon solon* (Fabricius, 1793), *Euchrysops snejuscnejus* (Fabricius, 1798), *Euthalia aconthea meridionalis* (Fruhstorfer, 1906), *Kallimahorsfieldii* (Kollar, 1844), *Lampides boeticus* (Linnaeus, 1767), *Prosotas noraardates* (Moore, 1875), *Spindasis elimaelima* (Moore, 1877), under schedule ii and *Appias libythea* (Fabricius, 1775) is under schedule iv of WPA 1972 (Anon., 2006). Ecological inventories are important to maintain baseline data for future research to evaluate the shifts in species composition due to urbanization or other anthropogenic pressure (Trivedi et al., 2022).

**Table 1. List of butterfly species of Navsari Agricultural University, Navsari, Gujarat**

No. #	Common Name	Zoological Name	WPA Status	Status*
<b>(A) Family: Nymphalidae</b>				
1	Baronet	<i>Symphaedranais</i> (Forster, 1771)	NA	UC
2	Chinese Lemon Pansy	<i>Junonia lemonias</i> (Linnaeus, 1758)	NA	VC
3	Common Four-ring	<i>Ypthima huebneri</i> (Kirby, 1871)	NA	C
4	Coromandel Glassy Tiger	<i>Parantica aglea</i> (Stoll, 1782)	NA	UC
5	Dakhan Common Baron	<i>Euthalia aconthea meridionalis</i> (Fruhstorfer, 1906)	Sched II	R
6	Dakhan Common Bush brown	<i>Mycalesis perseustabitha</i> (Fabricius, 1793)	NA	C
7	Dakhan Common Castor	<i>Ariadne merionemerione</i> (Cramer, 1777)	NA	R
8	Danaid Eggfly	<i>Hypolimnasmisippus</i> (Linnaeus, 1764)	Sched I & II	VC
9	Himalayan Common Palmfly	<i>Elymnias hypermnestra undularis</i> (Drury, 1773)	NA	R
10	Indian Common Crow	<i>Euploea core core</i> (Cramer, 1780)	NA	VC
11	Indian Common Sailer	<i>Neptishylas varmona</i> (Moore, 1872)	NA	C
12	Oriental Blue Tiger	<i>Tirumala limniace exotica</i> (Gmelin, 1790)	NA	R
13	Oriental Chocolate Pansy	<i>Junonia iphita iphita</i> (Cramer, 1779)	NA	VC
14	Oriental Commander	<i>Moduzaprocris procris</i> (Cramer, 1777)	NA	UC
15	Oriental Common Evening Brown	<i>Melanitis leda leda</i> (Linnaeus, 1758)	NA	C
16	Oriental Common Leopard	<i>Phalanta phalantha phalantha</i> (Drury, 1773)	NA	C
17	Oriental Great Eggfly	<i>Hypolimnasmisippus</i> (Drury, 1773)	NA	VC
18	Oriental Grey Pansy	<i>Junonia atites atites</i> (Linnaeus, 1763)	NA	VC
19	Oriental Peacock Pansy	<i>Junonia almana almana</i> (Linnaeus, 1758)	NA	VC

**Comment [SL2]:** I am absolutely surprised that *L. boeticus* would be protected under any category in the wild animals protection act, due to the fact that the species is a very common pest which is responsible for crop damage on the legumes, one of its larval food plants. The problem is especially wide-spread in India and it is absolutely mind boggling to me that the species would be protected? Also, the reference you are citing is already outdated and in the case of such acts, only the newest versions should be applied and cited.

**Comment [SL3]:** The entire table arrangement is weird, especially since the butterflies should not be listed according to the alphabetical order of their English names. Why English names in the first place? In such articles (scientific ones) Latin names are the most appropriate ones, since many of us from non-English speaking countries are not even familiar with the English names of most butterflies. Thus, the butterflies should be listed according to the appropriate taxonomical nomenclature and not alphabetical order. Especially not by the alphabetical order of their English names. English names could even be excluded from the table or could only be included as "a bonus" of sorts.

20	Oriental Plain Tiger	<i>Danaus chrysippuschrysippus</i> (Linnaeus, 1758)	NA	VC
21	Oriental Striped Tiger	<i>Danaus genutiagenutia</i> (Cramer, [1779])	Sched I	VC
22	Oriental Yellow Pansy	<i>Junoniahiertahieria</i> (Fabricius, 1798)	NA	R
23	Painted Lady	<i>Vanessa cardui</i> (Linnaeus, 1758)	NA	R
24	Pale Black Rajah	<i>Charaxes solon solon</i> (Fabricius, 1793)	Sched II	R
25	Pale Blue Pansy	<i>Junoniaorithya</i> (Linnaeus, 1758)	NA	UC
26	Sahyadri Blue Oakleaf	<i>Kallimahorsfieldii</i> (Kollar, 1844)	Sched II	R
27	Sri Lankan Club Beak	<i>Libytheamyrrharama</i> (Moore, 1872)	NA	R
28	Tawny Coster	<i>Acraea terpsicore</i> (Linnaeus, 1758)	NA	VC

**(B) Family: Lycaenidae**

29	Asian Zebra Blue	<i>Leptotespliniusplinius</i> (Fabricius, 1793)	NA	VC
30	Assam Opaque Six-Lineblue	<i>Nacadubaberoegythion</i> (Fruhstorfer, 1916)	NA	UC
31	Continental Common Pierrot	<i>Castaliusrosimonrosimon</i> (Fabricius, 1775)	Sched I	VC
32	Dakhan Orange-crowned Cupid	<i>Evereslacturnussyntala</i> (Cantlie, 1963)	NA	VC
33	Dakhan Pointed Ciliate Blue	<i>Anthenelycaeninalycaenina</i> (R. Felder, 1868)	Sched II	VC
34	Indian Common Lineblue	<i>Prosotasnoraardates</i> (Moore, 1875)	Sched II	VC
35	Indian Common Shot Silverline	<i>Spindasisictisictis</i> (Hewitson, 1865)	NA	R
36	Indian Common Silverline	<i>Spindasisvulcanusvulcanus</i> (Fabricius, 1775)	NA	R
37	Indian Dark Cerulean	<i>Jamidesbochusbochus</i> (Stoll, 1782)	NA	R
38	Indian lesser grass blue	<i>Zizinaotisindica</i> (Murray, 1874)	NA	VC
39	Indian Lime Blue	<i>Chiladeslajuslajus</i> (Stoll, 1780)	NA	C
40	Indian Red Pierrot	<i>Talicedanyseusnyseus</i> (Guérin-Méneville, 1843)	NA	UC
41	Indian Scarce Shot Silverline	<i>Spindasiselimaelima</i> (Moore, 1877)	Sched II	R
42	Indian Sunbeam	<i>Curetisthetis</i> (Drury, 1773)	NA	R
43	Indian Tiny Grass Blue	<i>Zizulahylaxhylax</i> (Fabricius, 1775)	NA	UC
44	Lankan Large Oakblue	<i>Arhopalaamantesamantes</i> (Hewitson, 1862)	NA	R
45	Oriental Common cerulean	<i>Jamidescelenocelena</i> (Cramer, 1775)	NA	C
46	Oriental Forget-me-not	<i>Catochrysopsstrabostrabo</i> (Fabricius, 1793)	NA	VC
47	Oriental Gram Blue	<i>Euchrysopsnejeusnejeus</i> (Fabricius, 1798)	Sched II	VC
48	Oriental Lesser Grass Blue	<i>Zizinaotisotis</i> (Fabricius, 1787)	NA	UC
49	Oriental Plains Cupid	<i>Chiladespandavapandava</i> (Horsfield, 1829)	NA	VC
50	Pea Blue	<i>Lampidesboeticus</i> (Linnaeus, 1767)	Sched II	VC
51	Tamil Large Guava Blue	<i>Viracholaperseghela</i> (Fruhstorfer, 1912)	NA	UC

**(C) Family: Pieridae**

52	Dakhan Common Gull	<i>Ceporanerissaphryne</i> (Fabricius, 1775)	Sched II	UC
53	Dakhan Large Salmon Arab	<i>Colotisfaustfulvia</i> (Wallace, 1867)	NA	UC
54	Dakhan Yellow Orange-tip	<i>Ixias pyrene sesia</i> (Fabricius, 1777)	NA	VC
55	Desert Small Salmon Arab	<i>Colotismataamata</i> (Fabricius, 1775)	NA	UC
56	Indian Crimson-tip	<i>Colotisdanaedanae</i> (Fabricius, 1775)	NA	R
57	Indian Jezebel	<i>Delias eucharis</i> (Drury, 1773)	NA	VC
58	Indian Little Orange-tip	<i>Colotisetridaetrida</i> (Boisduval, 1836)	NA	VC
59	Indian Pioneer	<i>Belenoisaurotaaurota</i> (Fabricius, 1793)	NA	VC
60	Indian Spotless Grass Yellow	<i>Euremalaetaetaeta</i> (Boisduval, 1836)	NA	VC
61	Indian Wanderer	<i>Pareroniahippia</i> (Fabricius, 1787)	NA	VC
62	Oriental Common Grass Yellow	<i>Euremahecabehcabecabe</i> (Linnaeus, 1758)	NA	VC

63	Oriental Lemon Emigrant	<i>Catopsiliapomonapomona</i> (Fabricius, 1775)	NA	VC
64	Oriental Mottled Emigrant	<i>Catopsiliapyranthepyranthe</i> (Linnaeus, 1758)	NA	VC
65	Oriental Psyche	<i>Leptosianinanina</i> (Fabricius, 1793)	NA	C
66	Plain Orange Tip	<i>Colotis aurora</i> (Cramer, 1780)	NA	VC
67	Red-line Small Grass Yellow	<i>Euremabrigitta rubella</i> (Wallace, 1867)	NA	C
68	Sahyadri One-spot Grass Yellow	<i>Eurema andersonii shimai</i> (Yata & Gaonkar, 1999)	NA	C
69	Sylhet Three-spot Grass Yellow	<i>Euremablandasilhetana</i> (Wallace, 1867)	NA	C
70	Western Striped Albatross	<i>Appiaslibythea</i> (Fabricius, 1775)	SchedIV	C
71	White Orange-tip	<i>Ixias marianne</i> (Cramer, 1779)	NA	C

(D) Family: HesperIIDae

72	Common Branded Redeye	<i>Matapa aria</i> (Moore, 1866)	NA	R
73	Grass Demon	<i>Udaspesfolus</i> (Cramer, 1775)	NA	R
74	Indian Grizzled Skipper	<i>Spialagalbagalba</i> (Fabricius, 1793)	NA	VC
75	Indian Palm Bob	<i>Suastusgremiusgremius</i> (Fabricius, 1798)	NA	VC
76	Oriental Dark Palm-Dart	<i>Telicotabambusaebambusae</i> (Moore, 1878)	NA	UC
77	Rice Swift	<i>Borbocinnara</i> (Wallace, 1866)	NA	VC

(E) Family: Papilionidae

78	Dakhan Common Jay	<i>Graphiumdosoneleius</i> (Fruhstorfer, 1907)	NA	C
79	Dakhan Tailed Jay	<i>Graphiumagamemnonmenides</i> (Fruhstorfer, 1904)	NA	UC
80	Indian Common Mormon	<i>Papiliopolytesromulus</i> (Cramer, 1775)	NA	VC
81	Indian spot Swordtail	<i>Graphiumnomiusnomius</i> (Esper, 1799)	NA	R
82	Northern Lime Swallowtail.	<i>Papiliodemoleusdemoleus</i> (Linnaeus, 1758)	NA	VC
83	Oriental Common Bluebottle	<i>Graphiumsarpedonsarpedon</i> (Linnaeus, 1758)	NA	R

# serial number corresponds with the figure numbers of plate for individual species, \*VC-Very Common ( $\geq 50$  individuals), C-Common (30-50 individuals), UC-Uncommon (5-30 individuals), R-Rare ( $\leq 5$  individuals); WPA- Indian Wildlife Protection Act, 1972 (Anon., 2006)

In the surveyed area, as per the IUCN threat category 4 species are listed under the red list viz. *Euploea core*, *Hypolimnasmisippus*, and *Junoniaalmana* are under the Least Concerned category, and *Castaliusrosimon* under the Vulnerable category. As per the sightings of the butterflies, 42% were very common (35), 17% common (14), 17% uncommon (14), and 24% were categorized rare (20) in the Navsari Agricultural University. *Graphiumnomius* a summer visitor in Gujarat is also found in NAU. Total of 45 species of butterflies has been reported from the Regional Institute of Education campus, Bhubaneswar (Priyamvada and Mohapatra, 2016).

**Fig. 1-24. Butterflies of the Navsari Agricultural University** (1. Baronet, 2. Chinese Lemon Pansy, 3. Common Four-ring, 4. Coromandel Glassy Tiger, 5. Dakhan Common Baron, 6. Dakhan Common Bush Brown, 7. Dakhan Common Castor, 8. Danaid Eggfly, 9. Himalayan Common Palmfly, 10. Indian Common Crow, 11. Indian Common Sailer, 12. Oriental Blue Tiger 13. Oriental Chocolate Pansy, 14. Oriental Commander, 15. Oriental Common Evening Brown, 16. Oriental Common Leopard, 17. Oriental Great Eggfly, 18. Oriental Grey Pansy, 19. Oriental Peacock Pansy, 20. Oriental Plain Tiger, 21. Oriental Striped Tiger, 22. Oriental Yellow Pansy, 23. Painted Lady, 24. Pale Black Rajah)

**Fig. 25-48. Butterflies of the Navsari Agricultural University** (25. Pale Blue Pansy, 26. Sahyadri Blue Oakleaf, 27. Sri Lankan Club Beak, 28. Tawny Coster, 29. Asian Zebra Blue, 30. Assam Opaque Six-Lineblue, 31. Continental Common Pierrot, 32. Dakhan Orange-crowned Cupid, 33. Dakhan Pointed Ciliate Blue, 34. Indian Common Lineblue, 35. Indian Common Shot Silverline, 36. Indian Common Silverline, 37. Indian Dark Cerulean, 38. Indian lesser grass blue, 39. Indian Lime Blue, 40. Indian Red Pierrot, 41. Indian Scarce Shot Silverline, 42. Indian Sunbeam, 43. Indian Tiny Grass Blue, 44. Lankan Large Oakblue, 45. Oriental Common cerulean, 46. Oriental Forget-me-not, 47. Oriental Gram Blue, 48. Oriental Lesser Grass Blue)

**Fig. 49-72. Butterflies of the Navsari Agricultural University** (49. Oriental Plains Cupid, 50. Pea Blue, 51. Tamil Large Guava Blue, 52. Dakhan Common Gull, 52. Dakhan Large Salmon Arab, 53. Dakhan Yellow Orange-tip, 55. Desert Small Salmon Arab, 56. Indian Crimson-tip, 57. Indian Jezebel, 58. Indian Little Orange-tip, 59. Indian Pioneer, 60. Indian Spotless Grass Yellow, 61. Indian Wanderer, 62. Oriental Common Grass Yellow, 63. Oriental Lemon Emigrant, 64. Oriental Mottled Emigrant, 65. Oriental Psyche, 66. Plain Orange Tip, 67. Red-line Small Grass Yellow, 68. Sahyadri One-spot Grass Yellow, 69. Sylhet Three-spot Grass

**Comment [SL4]:** Only the scientific (latin) names of the species should be included under the photographs, and not the english ones. This is a scientific article and not an educational one, despite being published in english language. This should be corrected for all photographs (1-83). Note that the photographs were deleted from the file only because the file was too large to upload. The photographs should still be included in the final article!

Yellow, 70. Western Striped Albatross, 71. White Orange-tip, 72. Common Branded Redeye) **Fig. 73-83. Butterflies of the Navsari Agricultural University** 73. Grass Demon, 74. Indian Grizzled Skipper, 75. Indian Palm Bob, 76. Oriental Dark Palm-Dart, 77. Rice Swift, 78. Dakhan Common Jay, 79. Dakhan Tailed Jay, 80. Indian Common Mormon, 81. Indian spot Swordtail, 82. Northern Lime Swallowtail, 83. Oriental Common Bluebottle.

#### 4. CONCLUSION

The urban greenscape of Agricultural University forms a manmade modified habitat that helps restore the native diversity of butterflies with limited resources. ~~The butterfly Our study clearly depicts shows that diverse a considerable phyto-resources plant diversity~~ plays a significant role in maintaining ~~the~~ diversity of the butterflies (Gandhi et al., 2015).

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**Comment [SL5]:** You cannot cite something as having an "anonymus" author. Due to the fact, that this is an Indian protection act you should consider citing Indian government or something similar entity as the first author. Also, there is already an updated version of this act which should be read and appropriately cited, as the version from 2006 is outdated.

**Comment [SL6]:** The version should be updated and any changes applied to the manuscript.

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