

# Original Research Article

## Butterfly Diversity of Navsari Agricultural University (NAU), Navsari, Gujarat, India

### Abstract

**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) and was performed 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 survey referencing different available literature 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. The Navsari Agricultural University campus hosts a wide variety of plant species, providing essential food and egg-laying sites for butterflies, which in turn plays a crucial role in determining the diversity and abundance of butterfly species found in the area.

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

**Keywords:** *Lepidoptera*, red list, host plant, Campus, urban landscapes, Butterfly's diversity, Papilionidae

## 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. They are often 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 few studied on butterflies.

Recently quite a few studies were conducted in urban and semi-urban landscapes of India and Gujarat (Parasharya and Jani, 2007; 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. In the southern Gujarat region, butterfly diversity has been recorded in Ankleshwar (Sidat and Bhatt, 2020) and Vansda (Bhalodia et al., 2002). 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 on the lush green campus of Navsari Agricultural University (NAU) campus.

This study represents the first systematic effort to assess and document butterfly species richness on the Navsari Agricultural University (NAU) campus. By providing a detailed inventory of butterfly diversity in this green urban space, the research not only contributes to the broader understanding of Lepidoptera in the Western Ghats but also highlights the significance of conserving such habitats. The findings could have important implications for local biodiversity conservation efforts, especially in urbanized regions where natural habitats are increasingly fragmented. Understanding the diversity

and distribution of butterflies in these areas is crucial for developing conservation strategies that ensure the sustainability of these species and their habitats.

## 2. MATERIAL AND METHODS

**2.1 Study area**-The Butterfly's diversity at the Navsari Agricultural University (NAU) was assessed from September 2020 to December 2022. The university (Lat-20.924660°, Long-72.907953°) sprawls over 3.45 km<sup>2</sup> in the Navsari district in Gujarat. The area's climate is generally humid and warm, receiving about 1500 mm of rainfall during the monsoon season (June-September). Winters (November-February) are moderately cold, while summers (March-May) are fairly hot and humid (Prajapati et al., 2023). The general habitat of Navsari Agricultural University in South Gujarat is represented by a notable presence of dry and moist deciduous forests within the region (Patel et al., 2022). 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 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 traditional 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. Occasional rare sightings were also considered while preparing the final checklist. Their status was 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), Peiridae (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 12 butterfly species are protected under scheduled categories of The Wild Life (Protection) Amendment act, 2022, i.e. *Castalius rosimonrosimon* (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 snejus snejus* (fabricius, 1798), *Euthalia aconthe meridionalis* (Fruhstorfer, 1906), *Kallimahorsfieldii* (kollar, 1844), *Prosotas noraardates* (moore, 1875), *Spindasis elima elima* (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. #	Zoological Name	Common Name	WPA Status	Status*
<b>Family: Nymphalidae</b>				
1	<i>Symphaedranais</i> (Forster, 1771)	Baronet	NA	UC
2	<i>Junonia lemonias lemonias</i> (Linnaeus, 1758)	Chinese Lemon Pansy	NA	VC
3	<i>Ypthima huebneri</i> (Kirby, 1871)	Common Four-ring	NA	C
4	<i>Parantica aglea aglea</i> (Stoll, 1782)	Coromandel Glassy Tiger	NA	UC
5	<i>Euthalia aconthe meridionalis</i> (Fruhstorfer, 1906)	Dakhan Common Baron	Sched II	R
6	<i>Mycalesis perseustabitha</i> (Fabricius, 1793)	Dakhan Common Bush brown	NA	C
7	<i>Ariadne merionemerione</i> (Cramer, 1777)	Dakhan Common Castor	NA	R
8	<i>Hypolimnasmisippus</i> (Linnaeus, 1764)	Danaid Eggfly	Sched I & II	VC
9	<i>Elymniashypermnestra undularis</i> (Drury, 1773)	Himalayan Common Palmfly	NA	R
10	<i>Euploea core core</i> (Cramer, 1780)	Indian Common Crow	NA	VC
11	<i>Neptishylas varmona</i> (Moore, 1872)	Indian Common Sailer	NA	C
12	<i>Tirumala limniace exoticus</i> (Gmelin, 1790)	Oriental Blue Tiger	NA	R
13	<i>Junonia iphita iphita</i> (Cramer, 1779)	Oriental Chocolate Pansy	NA	VC
14	<i>Moduzaprocris procris</i> (Cramer, 1777)	Oriental Commander	NA	UC
15	<i>Melanitis leda leda</i> (Linnaeus, 1758)	Oriental Common Evening	NA	C

Brown

16	<i>Phalantaphalanthaphalantha</i> (Drury, 1773)	Oriental Common Leopard	NA	C
17	<i>Hypolimnasbolinajacintha</i> (Drury, 1773)	Oriental Great Eggfly	NA	VC
18	<i>Junoniaatlatesatlates</i> (Linnaeus, 1763)	Oriental Grey Pansy	NA	VC
19	<i>Junoniaalmanaalmana</i> (Linnaeus, 1758)	Oriental Peacock Pansy	NA	VC
20	<i>Danaus chrysippuschrysippus</i> (Linnaeus, 1758)	Oriental Plain Tiger	NA	VC
21	<i>Danaus genutiagenutia</i> (Cramer, [1779])	Oriental Striped Tiger	Sched I	VC
22	<i>Junoniahiertahiarta</i> (Fabricius, 1798)	Oriental Yellow Pansy	NA	R
23	<i>Vanessa cardui</i> (Linnaeus, 1758)	Painted Lady	NA	R
24	<i>Charaxes solon solon</i> (Fabricius, 1793)	Pale Black Rajah	Sched II	R
25	<i>Junoniaorithya</i> (Linnaeus, 1758)	Pale Blue Pansy	NA	UC
26	<i>Kallimahorsfieldii</i> (Kollar, 1844)	Sahyadri Blue Oakleaf	Sched II	R
27	<i>Libytheamyrrharama</i> (Moore, 1872)	Sri Lankan Club Beak	NA	R
28	<i>Acraea terpsicore</i> (Linnaeus, 1758)	Tawny Coster	NA	VC

**Family: Lycaenidae**

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

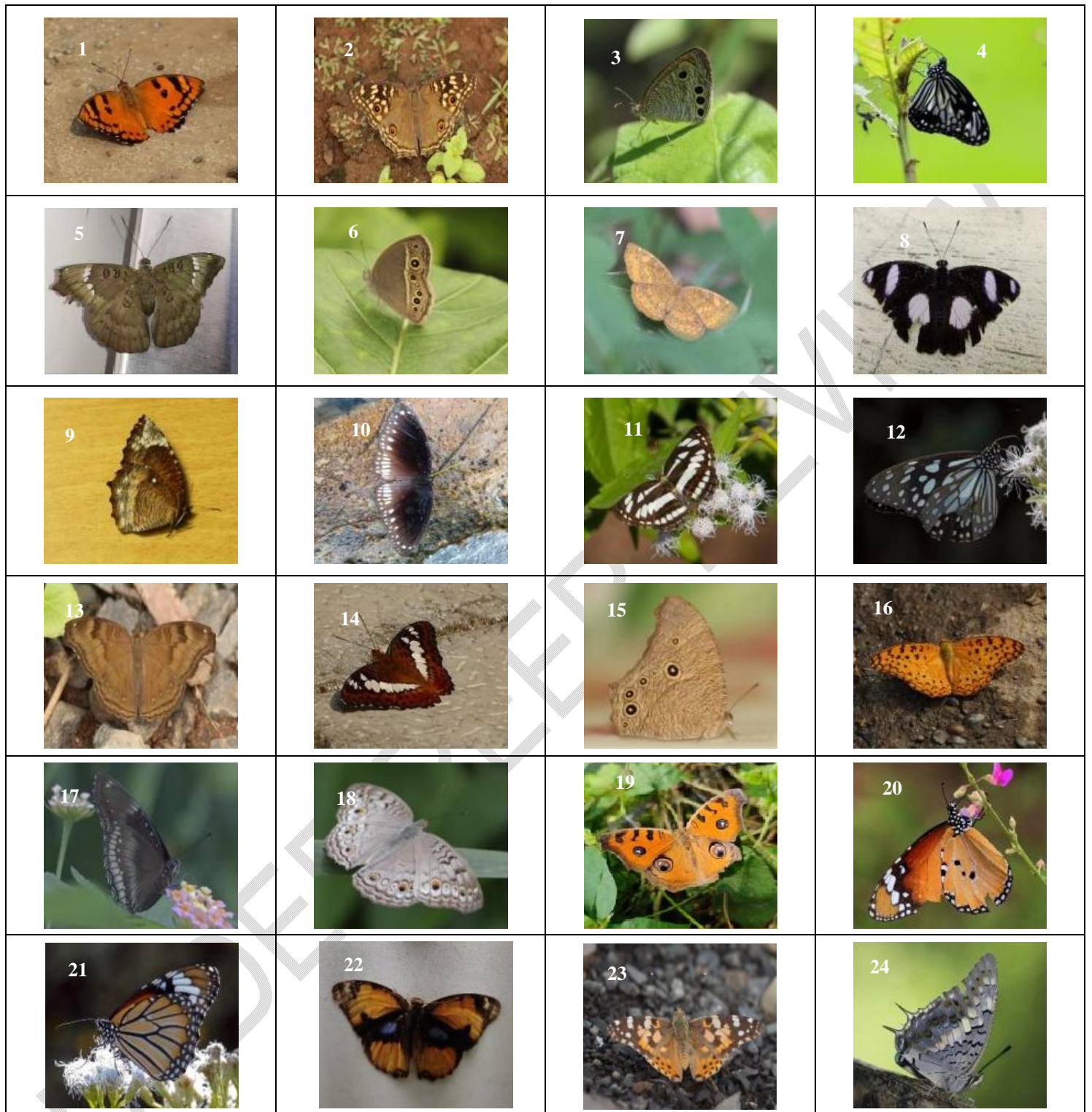
**Family: Peiridae**

52	<i>Ceporanerissaphryne</i> (Fabricius, 1775)	Dakhan Common Gull	Sched II	UC
53	<i>Colotisfaustafulvia</i> (Wallace, 1867)	Dakhan Large Salmon Arab	NA	UC
54	<i>Ixias pyrene sesia</i> (Fabricius, 1777)	Dakhan Yellow Orange-tip	NA	VC
55	<i>Colotisamataamata</i> (Fabricius, 1775)	Desert Small Salmon Arab	NA	UC
56	<i>Colotisdanaedanae</i> (Fabricius, 1775)	Indian Crimson-tip	NA	R
57	<i>Delias eucharis</i> (Drury, 1773)	Indian Jezebel	NA	VC
58	<i>Colotisetridaetrida</i> (Boisduval, 1836)	Indian Little Orange-tip	NA	VC
59	<i>Belenoisaurotaaurota</i> (Fabricius, 1793)	Indian Pioneer	NA	VC
60	<i>Euremalaetalaeta</i> (Boisduval, 1836)	Indian Spotless Grass Yellow	NA	VC
61	<i>Pareroniahippia</i> (Fabricius, 1787)	Indian Wanderer	NA	VC
62	<i>Euremahecabehecabe</i> (Linnaeus, 1758)	Oriental Common Grass Yellow	NA	VC
63	<i>Catopsiliapomonapomona</i> (Fabricius, 1775)	Oriental Lemon Emigrant	NA	VC
64	<i>Catopsiliapyranthepyranthe</i> (Linnaeus, 1758)	Oriental Mottled Emigrant	NA	VC
65	<i>Leptosianinanina</i> (Fabricius, 1793)	Oriental Psyche	NA	C

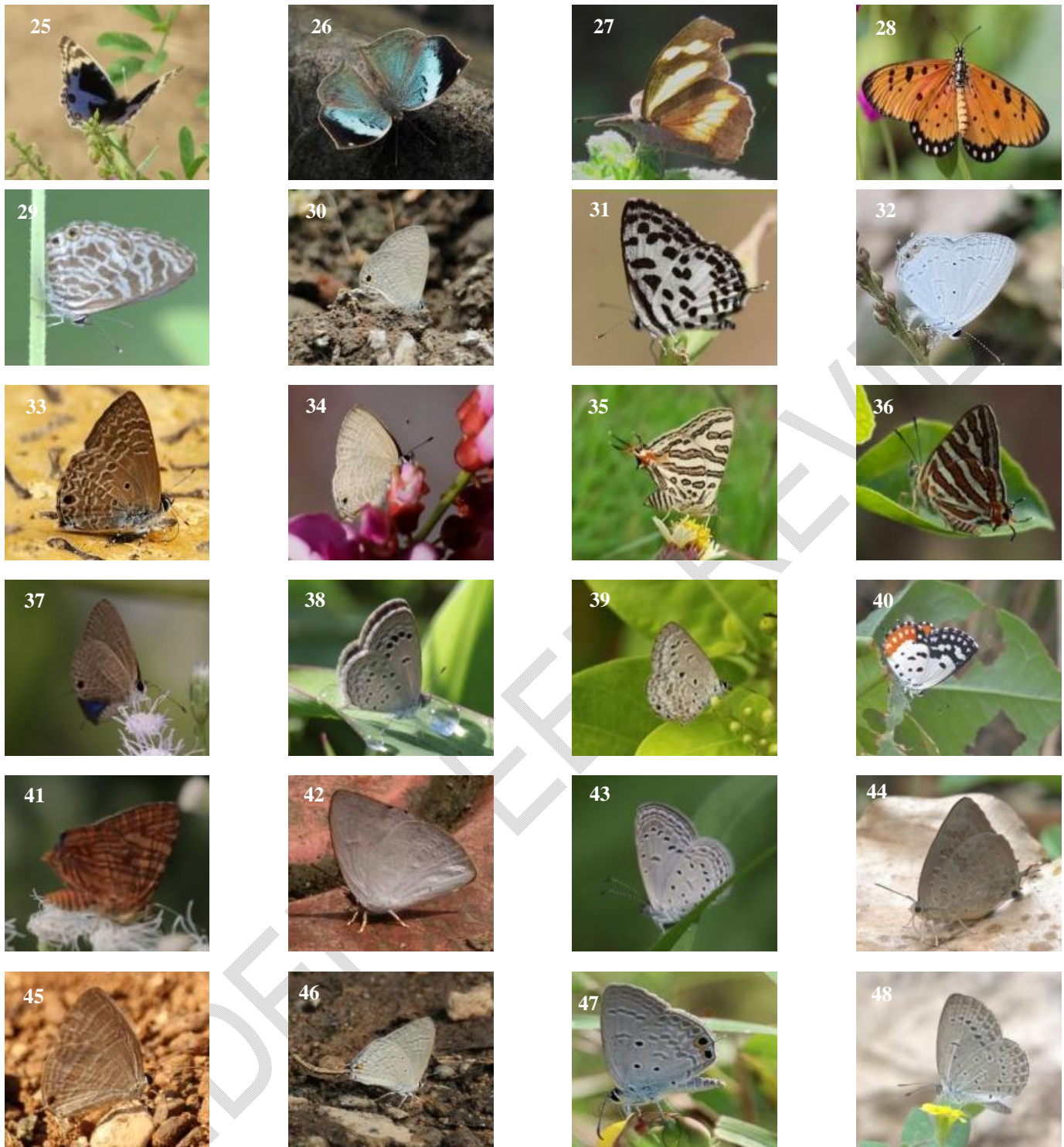
66	<i>Colotis aurora</i> (Cramer, 1780)	Plain Orange Tip	NA	VC
67	<i>Euremabrigitta rubella</i> (Wallace, 1867)	Red-line Small Grass Yellow	NA	C
68	<i>Eurema andersonii shimai</i> (Yata & Gaonkar, 1999)	Sahyadri One-spot Grass Yellow	NA	C
69	<i>Euremablandasilhetana</i> (Wallace, 1867)	Sylhet Three-spot Grass Yellow	NA	C
70	<i>Appiaslibythea</i> (Fabricius, 1775)	Western Striped Albatross	SchedIV	C
71	<i>Ixias marianne</i> (Cramer, 1779)	White Orange-tip	NA	C
<b>Family: Hesperidae</b>				
72	<i>Matapa aria</i> (Moore, 1866)	Common Branded Redeye	NA	R
73	<i>Udaspesfolus</i> (Cramer, 1775)	Grass Demon	NA	R
74	<i>Spialagalbagalba</i> (Fabricius, 1793)	Indian Grizzled Skipper	NA	VC
75	<i>Suastusgremiusgremius</i> (Fabricius, 1798)	Indian Palm Bob	NA	VC
76	<i>Telicotabambusaebambusae</i> (Moore, 1878)	Oriental Dark Palm-Dart	NA	UC
77	<i>Borbocinnara</i> (Wallace, 1866)	Rice Swift	NA	VC
<b>Family: Papilionidae</b>				
78	<i>Graphiumdosoneleius</i> (Fruhstorfer, 1907)	Dakhan Common Jay	NA	C
79	<i>Graphiumagamemnonmenides</i> (Fruhstorfer, 1904)	Dakhan Tailed Jay	NA	UC
80	<i>Papiliopolytesromulus</i> (Cramer, 1775)	Indian Common Mormon	NA	VC
81	<i>Graphiumnomiusnomius</i> (Esper, 1799)	Indian spot Swordtail	NA	R
82	<i>Papiliodemoleusdemoleus</i> (Linnaeus, 1758)	Northern Lime Swallowtail.	NA	VC
83	<i>Graphiumsarpedonsarpedon</i> (Linnaeus, 1758)	Oriental Common Bluebottle	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- [The wild life \(protection\) amendment act, 2022.](#)

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). Despite being located at the northern tip of the Western Ghats, Navsari Agricultural University is not situated near any forested areas. Nevertheless, it supports an impressive diversity of butterfly species, with 83 different species recorded within its relatively small area. This stands in stark contrast to the findings of Rai and Chaudhary (2023), who documented only 27 butterfly species in the Hastinapur Wildlife Sanctuary. The comparison highlights that, despite its limited size and lack of proximity to forests, Navsari Agricultural University demonstrates a remarkable potential to sustain a significantly higher diversity of butterflies. This suggests that certain factors within the university's environment, such as the availability of diverse plant species and suitable habitats, may be playing a crucial role in supporting this rich butterfly biodiversity.



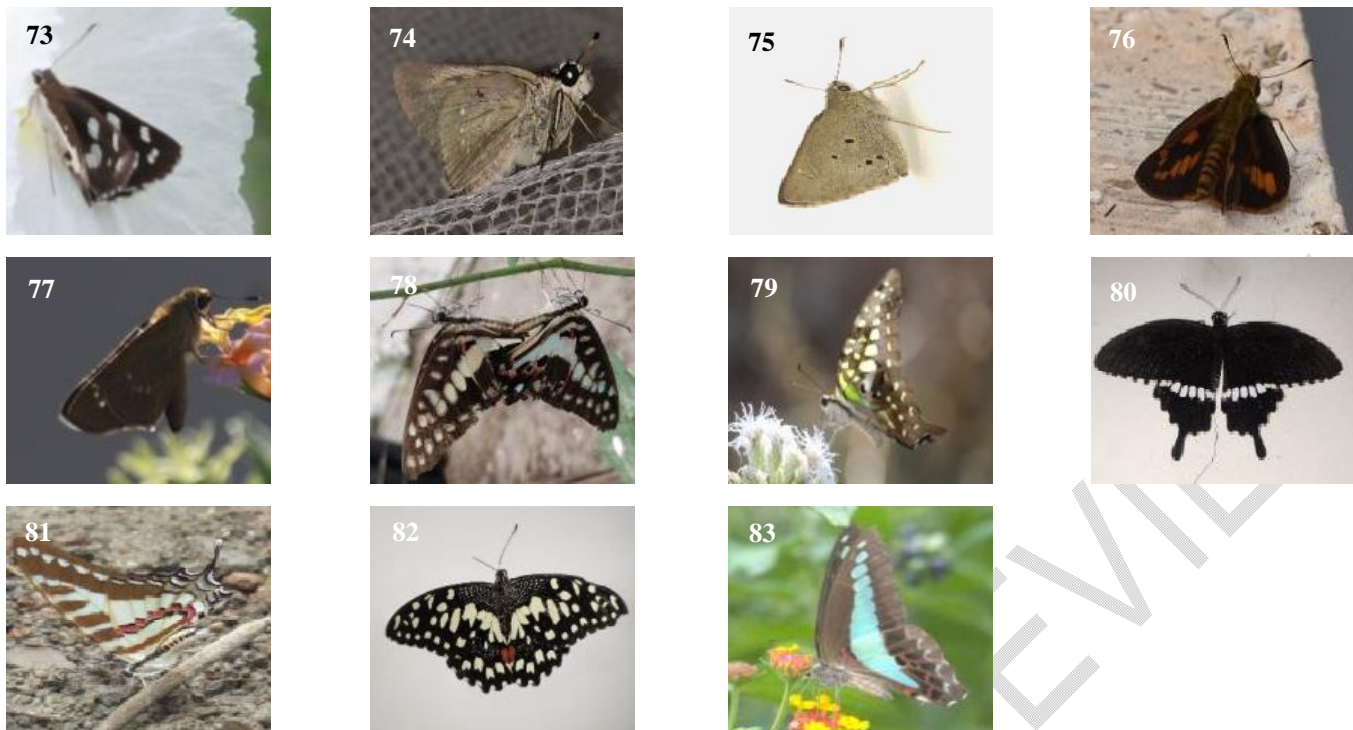
**Fig. 1-24. Butterflies of the Navsari Agricultural University**(1. *Symphaedranais*, 2. *Junonialemoniaslemonias*, 3. *Ypthimahuebneri*, 4. *Paranticaagleaaglea*, 5. *Euthaliaacontheameridionalis*, 6. *Mycalisperseustabitha*, 7. *Ariadne merionemerione*, 8. *Hypolimnasmisippus*, 9. *Elymniashypermnestraundularis*, 10. *Euploea core core*, 11. *Neptishylasvarmona*, 12. *Tirumala limniaceexoticus*, 13. *Junoniaiphitaiphita*, 14. *Moduzaprocrisprocris*, 15. *Melanitisedaleda*, 16. *Phalantaphalanthaphalantha*, 17. *Hypolimnasbolinajacintha*, 18. *Junoniaatlitesatlites*, 19. *Junoniaalmana almanac*, 20. *Danaus chrysippuschrysippus*, 21. *Danaus genutiagenutia*, 22. *Junoniahiertahiarta*, 23. *Vanessa cardui*, 24. *Charaxes solon solon*)



**Fig. 25-48. Butterflies of the Navsari Agricultural University**(25. *Junonia orithya*, 26. *Kallimahorsfieldii*, 27. *Libythea myrrharama*, 28. *Acraea terpsicore*, 29. *Leptotes plinius plinius*, 30. *Nacaduba beroegythion*, 31. *Castalius rosimon rosimon*, 32. *Everes lacturnus syntala*, 33. *Anthenelycaenina lycaenina*, 34. *Prosotas nora airdates*, 35. *Spindasis tictis tictis*, 36. *Spindasis vulcanus vulcanus*, 37. *Jamides bochus bochus*, 38. *Zizinaotis indica*, 39. *Chilades lajus lajus*, 40. *Talica danyseus nyseus*, 41. *Spindasis elima elima*, 42. *Curetisthetis*, 43. *Zizula hylax hylax*, 44. *Arhopala amantes amantes*, 45. *Jamides celeno celeno*, 46. *Catochrysops strabo Strabo*, 47. *Euchrysops snejus snejus*, 48. *Zizinaotis*)



**Fig. 49-72. Butterflies of the Navsari Agricultural University** (49. *Chiladespandavapandava*, 50. *Lampidesboeticus*, 51. *Viracholaperseghela*, 52. *Ceporanerissaphryne*, 53. *Colotisfaustafulvia*, 54. *Ixias pyrene sesia*, 55. *Colotismataamata*, 56. *Colotisdanaedanae* (Photo not captured), 57. *Delias eucharis*, 58. *Colotisetridaetrida*, 59. *Belenisaurotaaurota*, 60. *Euremalaetalaeta*, 61. *Pareroniahippia*, 62. *Euremahecabehecabe*, 63. *Catopsilia pomonapomona*, 64. *Catopsiliapyranthepyranthe*, 65. *Leptosianinanina*, 66. *Colotis aurora* (Photo not captured), 67. *Euremabrigitta rubella* (Photo not captured), 68. *Euremaandersoniishimai*, 69. *Euremablandasilhetana*, 70. *Appiaslibythea*, 71. *Ixias marianne*, 72. *Matapa aria*)



**Fig. 73-83. Butterflies of the Navsari Agricultural University**(73. *Udaspesfolus*, 74. *Spialagalbagalba*, 75. *Suastusgremiusgremius*, 76. *Telicotabambusaebambusae*, 77. *Borbocinnara*, 78. *Graphiumdosoneleius*, 79. *Graphiumagamemnonmenides*, 80. *Papiliopolytesromulus*, 81. *Graphiumnomiusnomius*, 82. *Papiliodemoleusdemoleus*, 83. *Graphiumsarpedonsarpedon*)

#### 4. CONCLUSION

The urban greenscape of Agricultural University forms a manmade modified habitat that helps restore the native diversity of butterflies with limited resources. Our study shows that a considerable plant diversity plays a significant role in maintaining the diversity of the butterflies (Gandhi et al., 2015). It is evident that Navsari Agricultural University (NAU), Navsari, Gujarat has a diverse butterfly fauna.

#### 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.

#### REFERENCES

1. The wild life (protection) amendment act, 2022. [Http://www.indiaenvironmentportal.org.in/files/file/wildlife%20protection%20amendment%20act%202022.pdf](http://www.indiaenvironmentportal.org.in/files/file/wildlife%20protection%20amendment%20act%202022.pdf). Accessed on 09/08/2024.
2. Arya MK, Dayakrishna and Chaudhary R. Species richness and diversity of butterflies in and around Kumaun University, Nainital, Uttarakhand, India. *Journal of Entomology and Zoology Studies*. (2014);2(3):153-159.
3. Bhalodia K, Bhuva VJ, Dave SM and Soni VC. Butterflies of Vansda, Gujarat. *Zoos' Print Journal*. (2002)17(10):903-904.
4. Bhatt UM and Nagar PS. Diversity of butterflies in an arboretum of Vadodara, Gujarat, India. *Check List*. (2017)13(2). <https://doi.org/10.15560/13.2.2073>

5. Evans WH. The Identification of Indian Butterflies. 2<sup>nd</sup> Edition. Bombay Natural History Society, Mumbai, India; 1932.
6. Gandhi N, Patel C, Padate G. Butterfly diversity around an irrigation reservoir in the semi-arid zone of central Gujarat, India: A consideration for conservation management. *Journal of Entomology and Zoology Studies*. (2018)6(2):2123-2128.
7. Gandhi S, Kumar D. Seasonal Diversity of Butterflies in the Fragmented Habitats of Waghai Botanical Garden of The Dangs - Gujarat. *International Journal of Biological Research*. (2016)4(2):237-244. <https://doi.org/10.14419/ijbr.v4i2.6651>
8. Gaonkar H. Butterflies of the Western Ghats, India including Sri Lanka: A biodiversity assessment of a Threatened Mountain System. Report. Bangalore: Indian Institute of Science. Centre for Ecological Sciences. (1996)89 pp.
9. IUCN. The IUCN Red List of Threatened Species. Version 2022-3. Retrieved 2022 April 25 from <https://www.iucnredlist.org>
10. Kaneria M, Kaneria M, Kushwah V. Diversity of butterflies (Lepidoptera) in Bilaspur district, Chhattisgarh, India. *Asian Journal of Experimental Biological Sciences*. (2013)4(2):282-287.
11. Kasambe R, Supekar P, Joshi O, Grampurohit B. Butterfly Diversity in the BNHS Nature Reserve, Goregaon, Mumbai (Lepidoptera: Rhopalocera). *Bionotes*. (2018)20:118-121.
12. Kehimkar I. Butterflies of India. (BNHS Field Guides). Bombay Natural History Society, Mumbai; 2016.
13. Kuhn E, Becker M, Harpke A, Kühn I, Kuhlicke C, Schmitt T, Settele J, Musche M. The benefits of counting butterflies: recommendations for a successful citizen science project. *Ecology and Society*. (2022)27(2):38. <https://doi.org/10.5751/ES-12861-270238>
14. Kumar A. Butterfly (Lepidoptera: Insecta) diversity from different sites of Jhagadia, Ankleshwar, district-Bharuch, Gujarat. *Octa Journal of Environmental Research*. (2013)1(1):09-18.
15. Kunte K, Sondhi S and Roy P. Butterflies of India, v. 4.16. Indian Foundation for Butterflies; 2023. <https://www.ifoundbutterflies.org>
16. Kunte K. India - A Lifescape: Butterflies of Peninsular India. Indian Academy of Science, Bangalore; 2000a.
17. Kunte K. Butterflies of Peninsular India. Universities Press (Hyderabad) and Indian Academy of Sciences (Bengaluru); 2000b.
18. Lawton JH, Bignell DE, Bolton B, Bloemers GF, Eggleton P, Hammond PM, Hodda M, Holt RD, Larsen TB, Mawdsley NA, Stork NE. Biodiversity inventories, indicator taxa and effects of habitat modification in tropical forest. *Nature*. (1998)391:72-76.
19. Malek SS, Prajapati VM, Desai BS. Enumeration of the host plants of *Dendrophthoe falcata* (L.F.) ETTINGSH var. *Falcate* at Navsari Agricultural University Campus, Gujarat. *Journal of Tropical Forestry*. (2021)37(I-II):54-62.
20. Mali M, Khokhariya BP, Dabgar YB. Biotic Interrelationship of Plants and Butterflies in Surrounding of Gandhinagar, Gujarat. *International Journal of Scientific Research*. (2014)3(4):420-422.
21. Mukherjee S, Aditya G, Basu P, Saha GK. Butterfly diversity in Kolkata metropolis: a synoptic checklist. *Check List*. (2016)12(2):1858. <http://doi.org/10.15560/12.2.1858>
22. Murphy DD, Wilcox BA. Butterfly diversity in natural habitat fragments: A test of the validity of vertebrate-based management. t. *Wildlife 2000: modeling habitat relationships of terrestrial vertebrates* (ed. by J. Verner, M.L. Morrison, and C.J. Ralph). University of Wisconsin Press, Madison; 1986.
23. Parasharya BM, Jani JJ. Butterflies of Gujarat, Anand Agricultural University, Anand; 2007.
24. Patel MH, Patel PC, Malek SS, Ram ML, Desai BS, Parekh VB, Jha SK. Model nursery of medicinal and aromatic plants at NAU, Navsari: Initiative towards production of quality planting material & conservation of herbal resources. *The Pharma Innovation Journal*. (2022)SP-11(1):1198-1206.
25. Patel M, Kapdi P, Tandel N, Desai J, Patel Z. Diversity and conservation status of avifauna in western Navsari, South Gujarat - 10 years of observations. *Species*. (2022)23(72):369-389.
26. Paul M, Sultana A. Studies on butterfly (Insecta: Lepidoptera) diversity across different urban landscapes of Delhi, India. *Current Science*. (2020)118(5):819-827. <https://doi.org/10.18520/cs/v118/i5/819-827>
27. Prajapati DR, Thakur NS, Gunaga RP, Bhuva D.C. Growth and production of *Melia dubia* under silvi-pasture systems and sole plantations: Positive implications of intercropping hybrid napier. *Indian Journal of Agroforestry*. (2023)25(1):41-47.
28. Priyamvada P, Mohapatra AK. A preliminary study on diversity of butterflies (Lepidoptera: Macrolepidoptera) in Regional Institute of Education campus, Bhubaneswar, Odisha, India. *Journal of Entomology and Zoology Studies*. (2016)4(2):489-496.
29. Ram ML, Malek S, Patel MH, Vashi BG, Parekh VB, Prajapati VM, Desai BS, Jha SK. Conservation of few threatened NTFP's (Trees) of South Gujarat. *The Pharma innovation Journal*. (2022)SP-11(1):338-341.
30. Rai and Chaudhary. A Study on the Diversity of Butterfly Species in Hastinapur Wildlife Sanctuary, Uttar Pradesh, India. *International Journal of Advanced Research in Biological Sciences*. (2023)10(5):17-26.
31. Sarjan HN. Butterfly Diversity in Manasagangothri campus of Mysore University. *Zoo's Print*. (2014)29(8):20-25.
32. Sekarappa S, Basavarajappa S. Impact of Pesticide application on butterfly fauna at agriculture ecosystems of Chamaraajanagar District, Karnataka, India. *Journal of Entomology and Zoology Studies*. (2016)4(6):401-407.

33. Shobana G, Gunasekaran C, Lena M, Agnes DA, Sharmila BA. Diversity and abundance of butterflies in Villupuram District, Tamil Nadu, South India. *International Journal of Recent Scientific Research*. (2012)3(7):637-639.
34. Shull EM. The Butterflies of South Gujarat & Supplementary Note. *The journal of the Bombay Natural History Society*. (1964)60:585-599.
35. Sidat A, Bhatt U Annotated checklist of butterflies of Ankleshwar—an industrial town in Gujarat, India. *Check List*. (2020)16(4):997-1015. <https://doi.org/10.15560/16.4.997>
36. Singh AP. *Butterflies of India*. OM Books International, Noida, India;2011.
37. Suthar AR, Sankhwal AO, Rathod JY, Gavali DJ. Rapid Assessment of Butterfly Diversity and Host plants at Piplaidevi Forest Range, Dangs, Gujarat. *Bio Bulletin*. (2019)5(1):25-31.
38. Thangapandian M, Ganesh A, Ramaraj P, Selvakumar C, Janarthan S. Diversity and status of butterflies in the city of Chennai, Tamil Nadu. *Hexapoda (Insecta Indica)*. (2014)21(1):1-9.
39. Tiple AD. Butterfly species diversity, relative abundance, and status in tropical forest research institute, Jabalpur, Madhya Pradesh, Central India. *Journal of Threatened Taxa*. (2012)4(7):2713-2717. <https://doi.org/10.11609/JoTT.o2656.2713-7>
40. Trivedi D, Makwana VM, Shukla AH, Dodia PP. Diversity of butterflies in Victoria Park Reserve Forest, Bhavnagar, Gujarat, India. *Notulae Scientia Biologicae*. (2022)14(3):11293. <https://doi.org/10.55779/nsb14311293>
41. Varshney RK, Smetacek P. *A Synoptic Catalogue of the Butterflies of India*, 1st ed. Butterfly Research Centre, Bhimtal&Indinov Publishing, New Delhi; 2015.

UNDER PEER REVIEW