

Abundance and diversity of butterflies and their host plants in A.V.C. College campus, Mayiladuthurai, Tamil Nadu, India

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Abstract

Butterflies are one of the good indicators of environment, as they are sensitive to disturbance including climate change. This manuscript documents the abundance and diversity of butterflies in A.V.C. College Campus, Mayiladuthurai, Tamil Nadu. The study identified 30 species of butterflies belonging to five families viz., Nymphalidae (12 spp.), Pieridae (6 spp.), Lycaenidae (2 spp.), Papilionidae (4 spp.), and Hesperidae (2 spp.). Among these 51 species of butterflies, *Zizeeria karsandra* showed the highest abundance, contributing to over 30% of total sightings. The abundance (464 ± 33 individuals/day), diversity (2.27 ± 0.03) and richness (30 spp.) of butterflies recorded the maximum between first and second week of December 2016. This could be due the availability of suitable habitats with favorable environmental conditions. Butterfly abundance increased positively with temperature and humidity, though not significantly ($p > 0.05$).

Butterfly feeding on nectar was observed on 20 different host plant species, with *Gomphrena serrata* receiving the highest number of butterflies. Herbaceous plants received the highest butterfly visit (92%) followed by grass (6%). Most of the visits of butterflies were on yellow flowers (51%) followed by white flowers (23%). More than two thirds of butterflies' visits were to open (65%) compared to tubular flowers (35%). The highest visits to herbaceous plants with yellow and open flowers could be a function of their higher fragrance along with higher quantity nectars compared to the plants, with white colored and tubular flowers. Detailed screening on the photochemical components of flowers and quantity of nectar in flowers would be essential to understand butterfly feeding in relation to plant and flower characteristics.

Key words : abundance, butterfly, diversity, environmental condition, host plants.



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INTRODUCTION

Insects contribute to more than half of all the species on the planet with recent studies estimating the existing insect diversity to be nearly 30 million species (Battist1988; May 1992; Godfrey *et al.* 1999). Butterflies are regarded as one of the best taxonomically studied group of insects around the globe due to their vivid morphology and taxonomic complexities among the Lepidopteron insects (Gaonker, 1996). The order Lepidoptera constitutes of the majority of visually appealing insects such as the butterflies and moths with 1,25,000 to 1,50,000 described species (Gullan and Cranston, 2009). There are about 28000 species of butterflies around the world, in which 18,000 known species are recorded (Mobeen *et al.* 2016). The Indian subcontinent has about 1501 species of butterflies, with about 321 skippers, 107 swallowtails, 443 blues, 521 brush footed butterflies and 109 whites and yellows (Kehimkar, 2008; Kunte 2009; Wadatkar and Kasambe, 2009).

Studies on the diversity of butterflies in any area benefits the understanding the status of an ecosystem (Meeta and Noopur, 2017). Information on the diversity of butterflies has been studied throughout India. The major observations are from Himalayan regions (Singh 2009; Sidhu 2011; Quereshi *et al.* 2014), North East (Gogoi 2015; Gogoi *et al.* 2016), Semi Arid Zone (Sharma and Mattu 2010; Basavarajappa and Santhosh, 2018) Western Ghats (Gaonkar 1996; Kehimkar 2008; Ghorpade and Kunte 2010; Padhye *et al.* 2012; Priya *et al.* 2017), desert zone (Sharma and Sharma 2013), Deccan Peninsula regions (Kunte 2009; Narasimmarajan *et al.* 2014; Kumar and Murugesan 2014).

Butterflies and their caterpillars are dependent on specific host plants for foliage, nectar and pollen as their host (Gideon *et al.* 2016). Based on their color, odor and the shape of the flower butterflies forage on a specific plant. Thus, butterfly diversity indirectly reflects overall plant diversity, especially that of herbs and shrubs, in the given area. The landscape changes

in urban regions directly reflect the change in butterfly diversity and distribution. Many species of butterflies are strictly seasonal in their occurrence and prefer a particular set of habitats and host/host plants for their survival. Notably these beautiful insects are slowly disappearing due to changes in land pattern and habitat as they are closely dependent on plants. Studying the abundance and diversity of butterflies in urban habitats are much essential. Additionally, studies on the diversity and abundance of butterflies

in urban regions particularly in college and university campuses are very rare (Xavier, 2006; Ramesh *et al.*, 2010; Nair *et al.*, 2014; Panicker *et al.*, 2016) and therefore this study was undertaken in A.V.C College Campus.

MATERIALS AND METHODS

The study was conducted in A.V.C. College, which is located 5.5 km east of Mayiladuthurai, Tamil India, that falls between 11°6'14' N and 79°41'32 E. It has an elevation of about 22m and the flora of A.V.C College

Table 1. Check list of butterflies and their abundance observed in A.V.C. College campus.

Family (No. of species)	Common Name	Species Name	No. of Individuals
Hesperiidae (2)			4
	Common-banded Awl	<i>Hasora chormus</i>	2
	Rice Swift	<i>Borbo cinnara</i>	2
Lycaenidae (6)			817
	Dark Grass Blue	<i>Zizeeria karsandra</i>	203
	Grass Jewel	<i>Chilades trochylus</i>	270
	Oriental Grass Jewel	<i>Freyeria trochylus</i>	122
	Pale Grass Blue	<i>Zizeeria maha</i>	200
	Pea Blue	<i>Lampides boeticus</i>	20
	Plain Cupid	<i>Chilades pandava</i>	2
Nymphalidae (12)			1317
	Blue Pansy	<i>Junonia orithya</i>	1
	Blue Tiger	<i>Tirumala limniace</i>	5
	Chocolate Pansy	<i>Junonia iphita</i>	20
	Common Crow	<i>Euploea core</i>	1186
	Common Evening Brown	<i>Melanitis leda</i>	4
	Danaid Eggfly	<i>Hypolimnys misippus</i>	1
	Dark-branded Bush Brown	<i>Mycalesis mineus</i>	1
	Glassy Tiger	<i>Parantica aglea</i>	1
	Great Eggfly	<i>Hypolimnys bolina</i>	2
	Joker	<i>Byblia lthyia</i>	1
	Plain Tiger	<i>Danus chrysippus</i>	29
	Tawny Coster	<i>Acrae violae</i>	66
Papilionidae (4)			50
	Common Mormon	<i>Papilio poltes</i>	2
	Common Rose	<i>Pachliopta aristolochiae</i>	12
	Crimson Rose	<i>Pachliopta hector</i>	33
	Lime Butterfly	<i>Papilio demoleus</i>	3
Pieridae (6)			63
	Common Emigrant	<i>Catopsilia pomona</i>	3
	Common Grass Yellow	<i>Eurema hecabe</i>	17
	Common Jezebel	<i>Delias eucharis</i>	37
	Common Wanderer	<i>Pareronia valeria</i>	1
	Mottled Emigrant	<i>Catopsilia pyranthe</i>	1
	Psyche	<i>Leptosia nina</i>	4

Plate 1. Photography of notable butterfly species recorded in A.V.C. College Campus.



Rice swift



Dark Grass Blue



Oriental Grass Jewel



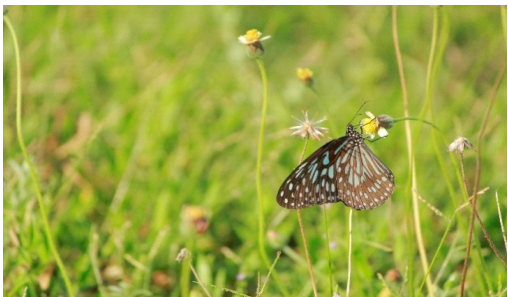
Pale Grass Blue



Plain Cupid



Blue Pansy



Blue Tiger



Chocolate Pansy



Common Crow



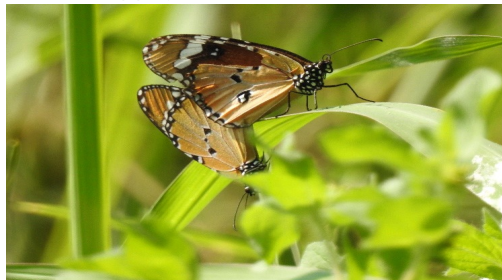
Common Evening Brown



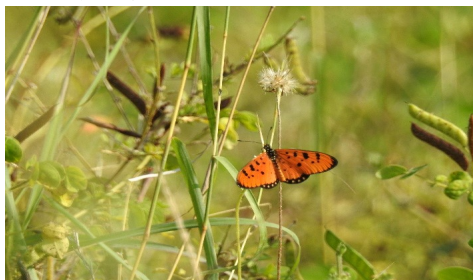
Danaid Eggfly



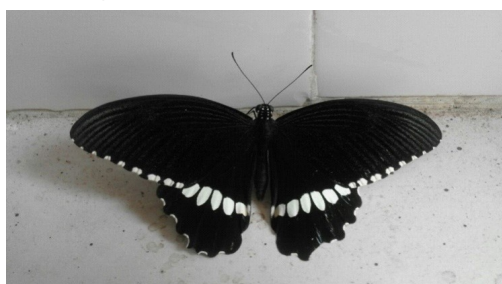
Glassy Tiger



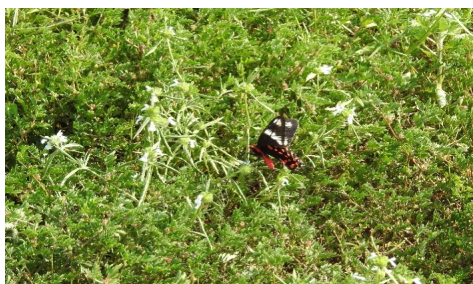
Plain Tiger



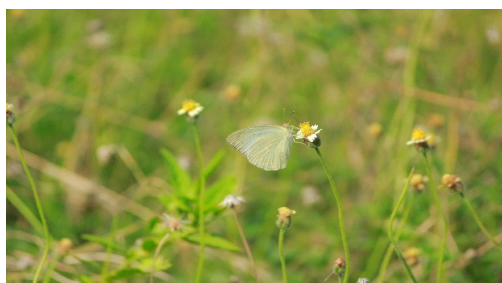
Tawny Coster



Common Mormon



Crimson Rose



Common Emigrant



Common Grass Yellow

has a great diversity and vegetation suitable for the diversity of the butterflies. The Campus has blessed with lush green vegetation having large trees, herbs, shrubs and grasses which support the occurrence of insect fauna including butterflies. The major plant species include, *Gomphrena serrata*, *Hedysarum kumaoones*, and *Leucas aspera* etc. Temperature and relative humidity were measured on the site with a Thermo-Hygrometer (Islam *et al.*, 2013). Temperature in the campus ranges from 20 to 33° C and humidity ranges between 42 and 91%. The average rainfall in Mayiladuthurai regions during the study was about 1290 mm.

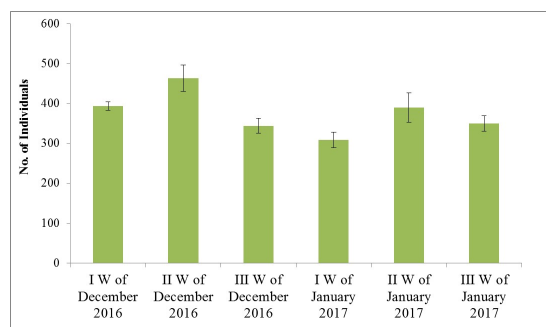


Fig. 1. Abundance of butterfly (mean \pm SE) recorded in A.V.C. College campus.

The butterflies in the campus were observed by direct observations, random walks and opportunistic observations mostly during the morning and evening hours from December 2016 to January 2017. Butterfly species were identified directly in the field visually with the help of field guides followed by photography, in difficult cases, rarely by capture. Since, identification up to the species level cannot be done

Table 2. Shannon Wiener Index (H') and Species Richness recorded in the study sites.

Month & Year	H'	Variance H'	Species Richness
I week of December 2016	2.27	0.004	30
II week of December 2016	1.49	0.003	14
III week of December 2016	2.04	0.004	19
I week of December 2017	1.7	0.004	16
II week of December 2017	1.45	0.002	13
III week of December 2017	1.81	0.002	16

with only photographs, additional methods used were survey methods wherein the individuals were collected by sweeping net. Once the butterfly is caught in the net, it is secured as quickly as possible in a fold of the net. Then they are gently placed with their wings folded together, antennae placed extended in paper envelopes of different sizes. Collection was restricted to those specimens that could not be identified directly. All scientific names follow Varshney (1983) and common English names follow Wynter-Blyth (1957). Gaonkar (1996) was followed for classification of butterflies and Benthum and Hooker (1862) system of classification followed for plants. Environmental parameters such as temperature and humidity also recorded during the study. Shannon Wiener diversity Index (H') was calculated using Species Diversity and Richness Software (Version 2.65).

RESULTS

The study identified 30 species of butterflies belonging to five families viz., Nymphalidae (12 spp.), Pieridae (6 spp.), Lycaenidae (6 spp.), Papilionidae (4 spp.), and Hesperidae (2 spp) (Table 1). Photography of the notable butterfly species recorded in the campus is given in plate 1. The study reveals that A.V.C college campus harbors a set of butterfly community wherein Nymphalidae individuals exerting dominance over the others. Among the five families recorded ,

Table 3. List of host plants used by butterflies in A.V.C. College campus.

Family (No of species)	Species	No. of individuals	Status	Activities
Acanthaceae (2)	<i>Nelsonia canescens</i>	30	Herb	Feeding
	<i>Ruellia turbosa</i>	16	Herb	Feeding & Basking
Amarathaceae (1)	<i>Gomphrena serrata</i>	652	Grass	Feeding
Asteraceae (1)	<i>Tridax procumbens</i>	301	Herb	Feeding & Basking
Boraginaceae (1)	<i>Cynoglossum zeylanicum</i>	73	Herb	Feeding
Caricaceae (1)	<i>Carica papaya</i>	1	Tree	Feeding
Euphorbiaceae (1)	<i>Ricinus cummunis</i>	4	Herb	Feeding & Basking
Fabaceae (3)	<i>Clitoria ternatea</i>	37	Herb	Feeding
	<i>Hedysarum kumaones</i>	596	Herb	Feeding
	<i>Tephrosia purpurea</i>	121	Herb	Feeding
Lamiaceae (2)	<i>Clinopodium vulgare</i>	53	Herb	Feeding
	<i>Leucas aspera</i>	78	Herb	Feeding
Malvaceae(2)	<i>Sida acuta</i>	16	Herb	Feeding
	<i>Sida cordifolia</i>	47	Herb	Feeding & Basking
Poaceae (4)	<i>Alloteropsis cimicina</i>	33	Grass	Feeding
	<i>Apluda mutica</i>	2	Grass	Feeding & Basking
	<i>Panicum antidotale</i>	8	Grass	Feeding & Basking
	<i>Paspalidium flavidum</i>	4	Grass	Feeding & Basking
Rubiaceae (1)	<i>Ixora coccinea</i>	4	Herb	Feeding & Basking

Nymphalidae showed the highest abundance followed by Lycaenidae and Pieridae, while the lowest abundance was recorded in Hesperidae. Among 12 species recorded in family Nymphalidae, Common Crow showed the maximum number followed by Tawny Coster and Plain Tiger. Among the six species butterflies recorded in Lycaenidae, Grass Jewel recorded the maximum followed by Dark Grass Blue and Pale Grass Blue. Common Jezebel and Common Grass Yellow were the most dominant species in Pieridae family. Among the four species noted in family Papilionidae, Crimson Rose recorded the maximum individuals followed by Common Rose (Table 1). The abundance (464 ± 33 individuals/day), diversity (2.27 ± 0.03) and the species richness (30 spp.) were the maximum between first and second week of December 2016 (Fig. 1 and Table 2). Butterfly abundance increased with temperature and humidity, even though the increase was not statistically significant ($p > 0.05$).

A total of 20 species plants belong to 11 families were recorded as host plants used by butterflies in the study area. Among 11 families, Amarathaceae hosted the highest number of butterflies followed by Fabaceae, whereas Amarathaceae, Asteraceae, Boraginaceae, Caricaceae, Euphorbiaceae and Rubiaceae had the lowest numbers. Among the plant species, *Gomphrena serrata* received the maximum number of butterflies followed by *Hedysarum kumaones*, while *Carica papaya* hosted the minimum numbers (Table 3). Among 20 species of plants recorded, 11 species of plants namely *Nelsonia canescens*, *Gomphrena serrata*, *Cynoglossum zeylanicum*, *Carica papaya*, *Clitoria ternatea*, *Hedysarum kumaones*, *Tephrosia purpurea*, *Clinopodium vulgare*, *Leucas aspera*, *Sida acuta* and *Alloteropsis cimicina* were exclusively used by the butterflies for feeding the nectars and remaining nine species used either for basking and feeding (Table 3). The herbaceous plants received the highest number of butterflies (92%) followed by grasses (6%) and most of the butterfly visits were on yellow colored (51%) flowers followed by white colored flowers (25%). More than two thirds of total visits were to open (65%) compared to tubular flowers (35%). The higher visits to herbaceous plants with yellow and open flowers could be a function of their higher fragrance along with higher quantity nectars compared to the other set of plants, which are with white colored and tubular flowers.

DISCUSSION

Butterflies play a vital role in ecosystem restoration as pollinators. Increase in butterfly populations may indicate an increase in plant diversity and other pollinator groups within restored areas (Ghorpade and Kunte 2010; Padhye *et al.* 2012; Priya *et al.* 2017).

Butterflies benefits the environment in various aspects such as enhancing plant diversity as pollinators, ecological indicators, provide food for other organisms, predators controlling other insects, and reduces pollution (Mobeen *et al.*, 2016). Recent studies have highlighted the importance of institutional campuses as a preferred habitat for butterflies. The flora of A.V.C College has a great diversity and vegetation suitable for the diversity of the butterflies. The present study recorded 30 species of butterflies indicating the quality of vegetations in college campus. The number of butterflies recorded in the present study is comparable with the species number note in veterinary and animal sciences campus, Mannuthy (Panicker *et al.* 2016). Tiple *et al.* (2007) recorded 52 species of butterflies in an Indian university campus. Aiswarya *et al.* (2014) reported 49 species of butterflies in Sarojini Naidu College campus. A total of 68 species of butterflies are recorded in Andhra University campus Vishakhapatnam (Rao *et al.*, 2003) and the numbers of species recorded in present study are comparable with the previous studies.

Occurrence and distributions of butterflies are depending upon the availability of their host plants (Feltwell, 1986). A.V.C College campus is blessed with lush green vegetation having large trees, herbs, shrubs and grasses which support the diversity of butterflies. The major plant species include, *Gomphrena serrata*, *Hedysarum kumaones*, and *Leucas aspera*. It is presumed that the diversified flora in five different sites of this campus provides comfortable shelter, suitable foraging grounds and protection from predators and hostile atmospheric conditions to these butterflies. The growth rates of Lepidopteron individuals depend on the host plants with constitute the nutritional composition of the insects (Slansky and Wheeler, 1992). The majority of insects being herbivores are dependent on plants for nutrition and survival as reported earlier.

Plants like *Tridax procumbens*, *Alloteropsis cimicina*, *Clinopodium vulgare*, *clitoria ternatea*, *Cynoglossum zeylanicum*, *Tridax procumbens* and *Leucas aspera* attracted large number of butterflies in the campus. It is probably due to the fact that the flowering period of these herbs are throughout the year in the campus. Asteraceae family is the most widely used plant family by the butterflies during the study, which is similar to the report of Nimbalkar *et al.* (2011) also reported in Pune. Similarly, Jeevith and Samyadurai (2015) reported that the Asteraceae family to be the most widely used nectar plant from Nilgries. The interaction between butterflies and their host plants appears to be an important aspect of biological diversification. In many stable ecological communities, plants have a major role in the determination of structure of community and

eventually the faunal diversity and their survival. It is because majority of insects being herbivorous are dependent on variety of plants for their nutrition and survival to complete their life cycle.

Butterflies are sensitive insects which react quickly to any kind of disturbance (Jeevith and Samyadurai 2015). There are many major factors affecting the butterfly population like changes in land patterns, loss of habitat structure and breeding habitat, environmental variation, extreme weather and climate change, change in abiotic environmental conditions, deforestation, overwintering range, predation, parasitism, microbial contaminants and pathogens (Kunte 2009; Narasimmarajan et al. 2014; Kumar and Murugesan 2014). Therefore, the regular monitoring of the diversity butterflies is highly warranted and thus our findings are important because butterflies are the indicator species and pollinating agents. A world without pollinators would be a world without apples. The geographical location of any area, its climatic conditions and vegetative composition are essential requisites for supporting a rich diversity of butterflies. Exploration of species diversity and understanding the habitat ecology in relation with nectar producing plants into a database is an imperative and also that will lead to the effective conservation of species. As this study was done only for the period of a few months, further detailed long term studies with investigations on the photochemical components of flowers and quantity of nectar in the flowers would shed better light in understanding the butterfly species diversity and plant pollination ecology.

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REFERENCES

- Aiswarya A.Nair, Pradarsika Mitra and Soma Aditya (Bandopadhyay). 2014. Studies on the diversity and abundance of butterfly (Lepidoptera: Rhopalocera) fauna in and around Sarojini Naidu College campus, Kolkota, West Bengal, India. *J. Entomol. Zool. Stud.*, 2(4): 129-134.
- Basavarajappa, S. and Santhosh, S. 2018. Butterfly species composition and diversity in a protected area of Karnataka, India. *Int. J. Biodivers. Conserv.*, 10 (10): 432-443. <https://doi.org/10.5897/IJBC2018.1215>
- Battist, A 1988. Phytophagous insect in the energy flow of an artificial stand of *Pinus nigra* Arnold in northern Italy, *Redia*, 71(1):139-160.
- Benthum, G. and J.D. Hooker 1862-1883. *Genera Plantarum* Vol. I, II, III. London, 1040, 1279, 1258 pp.
- Feltwell, J. 1986. *The Natural History of Butterflies*. Groom Helem Ltd. Provident House, Bureel Row, Beckenham Kent BR3 IAT 133PP.
- Gaonkar, H. 1996. *Butterflies of the Western Ghats, India (including Sri Lanka)*. A biodiversity assessment of a threatened mountain system. Report to the Centre for Ecological Sciences, Bangalore.
- Ghorpade, Kumar and Kunte. 2010. Butterflies (Lepidoptera-Rhopalocera) of the Palni Hills, southern Western Ghats in peninsular India: an updated review, with an appreciation of Brigadier WH Evans. *Colemania* 23: 1-19.
- Gideon, V. Anand Cyril Rufus, K. and Vivekraj, P 2016. A Study on nectar host plants of Butterflies of Pachamalai Hills of Eastern Ghats in Tamilnadu, India, *Ann. Biol. Res.* 7 (9): 9-12.
- Godfray, H.C.J., Lewis, O.T., Memmott, J. 1999. Studying insect diversity in the tropics. *Phil. Trans. R. Soc. Lond. B*. 354 (1391):1811-1824. 13. PMID:11605624 <https://doi.org/10.1098/rstb.1999.0523> PMID:PMC1692686
- Gogoi, M.J. 2015. Observations on lycaenid butterflies from Panbari Reserve Forest and adjoining areas, Kaziranga, Assam, northeastern India. *JoTT*. 7 (15): 8259-8271.
- Gogoi, M.J., Singha, S.H. and Deb, P. 2016. Butterfly (Lepidoptera) diversity in Barail Wildlife Sanctuary, Assam, India. *J. Entomol. Zool. Stud.*, 4 (4): 547-560.
- Gullan, P.J. and Cranston, P.S. 2009. *The Insects: An Outline of Entomology*, In the importance, diversity and conservation of insects. John Wiley and Sons Publishers, pp 4.
- Gunasekaran, J. 2015. Diversity of butterflies in different seasons in North-Eastern Tamilnadu, India. *Int. J. Modn. Res. Revs.* 3(11): 1029-1033.
- Islam, M. A., Parven, N., Islam, M. S. and Bashir, M.A. 2013. Butterfly abundance in relation to abiotic-biotic factors of forest ecosystem of the butterfly research park, Gazipur, Bangladesh. *Bangladesh J. Zool.* 41(2): 247-255. <https://doi.org/10.3329/bjz.v41i2.23328>
- Jeevith, S and Samyadurai, P. 2015. Butterflies nectar host plants from glenmorgan, the Nilgiris, Tamil Nadu, India. *IJPAJX-CAS-USA*, 5 (4) ISSN-2231-4490.
- Kehimkar, Issac .2008. *The Book of Indian Butterflies*. Bombay Natural History Society, Oxford University Press. 60-458.
- Kumar, P. and Murugesan, A.G. 2014. Species diversity and habitat association of butterflies around 30 km radius of Kudankulam Nuclear Power Plant area of Tamil Nadu, India. *Int. J. Biodivers. Conserv.* 6(8): 608-615. <https://doi.org/10.5897/IJBC2014.0729>

- Kunte, K. 2009. The diversity and evolution of Batesian mimicry in *Papilio swallowtail* butterflies. *Evolution: Int. J. Org. Evol.* 63(10): 2707-2716. <https://doi.org/10.1111/j.1558-5646.2009.00752.x> PMID:19552738
- May, P.G. 1992. Flower selection and the dynamics of lipid reserve in two nectarivorous butterflies. *Ecology*, 73(6): 2181-2191. <https://doi.org/10.2307/1941466>
- Mobeen, G., Muhammad, F.M., Mubashar H., Razia I and Misbah Y. 2016. Butterflies and their contribution in ecosystem: A review. *J. Entomol. Zool. Stud.*, 4(2): 115-118.
- Nair, A.V., Mitra, P. and Bandyopadhyay, S.A., 2014. Studies on the diversity and abundance of butterfly (Lepidoptera: Rhopalocera) fauna in and around Sarojini Naidu College campus, Kolkata, West Bengal, India. *J. Entomol. Zool. Stud.* 2(4): 129-134.
- Narasimmarajan, K., Vasava, A.K., Mahato, S., Parida, A. and Mathai, M.T. 2014. Butterflies Diversity in Gugamal National Park, in the Melghat Tiger Reserve, Maharashtra-Central India. *World J. Zool.* 9(2): 71-79.
- Nimbalkar, R.K., Chandekar, S.K. and Khunte, S.P. 2011. Butterfly diversity in relation to nectar host plants from Bhore Tahsil, Pune District, Maharashtra, India. *JoTT Short Communication* 3(3): 1601-1609. <https://doi.org/10.11609/JoTT.o2612.1601-9>
- Nowak, D.J. and Dwyer, J.F., 2007. Understanding the benefits and costs of urban forest ecosystems. In *Urban and community forestry in the northeast* (pp. 25-46). Springer, Dordrecht. https://doi.org/10.1007/978-1-4020-4289-8_2
- Padhye, A., Shelke, S. and Dahanukar, N. 2012. Distribution and composition of butterfly species along the latitudinal and habitat gradients of the Western Ghats of India. *Check List*. 8. 1197. <https://doi.org/10.15560/8.6.1197>
- Panicker, Varuna P., R. Anuraj, Govind Shankar, S. Aswathy, Anu Gopalakrishnan, and S. Biju. 2016. Studies on the diversity of butterfly (Lepidoptera: Rhopalocera) fauna in college of veterinary and animal sciences campus, Mannuthy, Thrissur, Kerala, India
- Parandhaman, D., Sivasankaran, K., Meerasa, M.N. and Ignacimuthu, S., 2012. Diversity of butterflies in different habitats from Tamilnadu part of Western Ghats (Lepidoptera: Rhopalocera). *Elixir Appl. Biol.* 51: 10861-10865.
- Priya, L., Krishnaraj, V. and Janaranjini, S., Lakeshmanaswamy. 2017. Studies on butterfly diversity in adichanallor Village, Kollam District, Kerala. *J. Entomol. Zool. Stud.* 5(5): 73-81.
- Qureshi, A.A., Bhagat, R.C. and Bhat, D.M., 2014. Diversity of butterflies (Lepidoptera: Papilionoidea and Hesperoidea) of Dachigam National Park, Jammu and Kashmir, India. *JoTT*, 6 (1), pp.5389-5392. <https://doi.org/10.11609/JoTT.o2886.5389-92>
- Raju, A.S., Zafar, R., Rao, S.P. and Ezradanam, V., 2003. Larval and adult food plants of Catopsilia butterflies at Andhra University Campus, Visakhapatnam. *Sci. Cult.* No.47: 1-49.
- Ramesh, T., Hussain, K.J., Selvanayagam, M., Satpathy, K.K. and Prasad, M.V.R. 2010. Patterns of diversity, abundance and habitat associations of butterfly communities in heterogeneous landscapes of the department of atomic energy (DAE) campus at Kalpakkam, South India. *Int. J. Biodivers. Conserv.*, 2(4): 75-85.
- Sharma, K.L. and Mattu, V.K. 2010. Diversity and bio-ecological assets of the northwest Himalayan orthopterans in Nalagarh valley of Himachal Pradesh, India. *Pest Manag. Econ. Zool.*, 18(1/2): 9-18.
- Sharma, M. and Sharma, N. 2013. Nectar resource use by Butterflies in Gir Wildlife Sanctuary, Sasan, Gujarat. *Int Biol. Forum. J.* 5(2): 56-63.
- Sharma M and Sharma, N. 2017. Suitability of Butterflies as Indicators of Ecosystem Condition: A Comparison of Butterfly Diversity across four habitats in Gir Wildlife Sanctuary. *Int. J. Adv. Res. Biol. Sci.*, 4(3): 43-53. <https://doi.org/10.22192/ijarbs.2017.04.03.005>
- Sidhu, A.K. 2011. Changing biodiversity scenario in the Himalayan ecosystem: Mussoorie, Uttarakhand, India, as revealed by the study of blue butterflies (Lycaenidae). *JoTT* 1559-1563.
- Singh, A.P. 2009. Butterflies of Kedarnath Musk Deer Reserve, Garhwal Himalaya, India. *Journal of Threatened Taxa*. 37-48. <https://doi.org/10.11609/JoTT.o1873.37-48>
- Slansky Jr, F. and Wheeler, G.S. 1992. Caterpillars' compensatory feeding response to diluted nutrients leads to toxic allelochemical dose. *Entomol. Exp. Appl.*, 65(2): 171-186. <https://doi.org/10.1111/j.1570-7458.1992.tb01641.x>
- Tiple, A. D., Khurad, A. M., & Dennis, R. L. 2007. Butterfly diversity in relation to a human-impact gradient on an Indian university campus. *Nota lepidopterologica*. 30 (1): 179.
- Varshney RK. Index Rhopalocera Indica Part III. Genera of Butterflies from India and neighbouring countries (Lepidoptera: (A) Papilionidae, Pieridae and Danaidae). *Oriental Insects*. 1993 Jan 1:27(1):347-72. <https://doi.org/10.1080/00305316.1993.10432285>
- Wadatkar, J.S. and Kasambe, R.A.J.U. 2009. Butterflies of Melghat Tiger Reserve, Maharashtra with notes on their abundance, status and larval host plants. *The Ecoscan*. 2: 165-171.
- Wynter-Blyth, M.A. 1957. Butterflies of the Indian Region. Bombay Natural History Society, Mumbai, 523pp.
- Xavier, A. 2006. Butterfly fauna of government arts and science college campus, Kozhikode, Kerala. *Zoos' Print J.*, 21(3): 2263-2264. <https://doi.org/10.11609/JoTT.ZPJ.1414.2263-4>