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Assemblage of Butterflies in Diverse Ecosystems of Cuddalore District, Tamil Nadu, India

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***Abstract*:** In the present study, pollard walk method was followed to estimate the diversity and assemblage of butterflies in diverse ecosystems of Cuddalore district, Tamil Nadu during March 2022 to February 2023. A total of 60 species and 44 genera were identified under five families *viz.,* Papilionidae (8 species), Pieridae (9), Nymphalidae (20), Lycaenidae (16) and Hesperiidae (7) were observed in the diverse ecosystems. The highest number of species were recorded in horticultural ecosystem (59 species) followed by semi-urban ecosystem (40) and agricultural ecosystem (38). The highest values for diversity indices of Simpson index (λ) (0.971), Shannon-Wiener (H1) (3.713), Margalef index (8.610), Menhinick (2.118) were recorded in horti-ecosystem and this higher index values indicate that the species are more diverse in the horti-ecosystem. The agricultural intensification decreases the butterfly fauna and unexpectedly, the semi-urban ecosystem which includes avenue trees, kitchen garden, ornamental flower plants, parks/ lawns serves a better habitat for butterflies. Therefore, the Evenness_e^H/S (0.805) and Equitability- J (0.941) were maximum in the semi-urban ecosystem. Berger Parker index (0.076) was maximum in Agro-ecosystem, which shows the community is dominated by the most common butterfly pest species in the rice crop.

Keywords: Biodiversity, Butterfly, Diversity Indices, Dominance, Ecosystem

Butterflies are an indicator species which responds rapidly to environmental and land use changes (Ekroos et al 2013) and have been recognized as ecological indicators in diverse ecosystems around the world (Stuhldrehera and Fartmann 2018). More than 18,000 butterfly species are known, and 90 % of these species are distributed in tropical areas (Bonebrake et al 2019). However, tropical butterfly diversity is threatened by habitat loss and global climate change (Jain et al 2017, Kirubaharan et al 2022). Butterflies perform important ecological functions, such as pollinating many plant species, and are thus highly valuable from a conservation perspective (Santos et al 2020). Butterflies are sensitive to climate and environmental change because of their short generation times, high mobility, and specific habitat preferences (Parmesan 2006). India hosts about 1,504 species belonging to different families viz., Papilionidae, Pieridae, Lycaenidae, Nymphalidae, Riodinidae and Hesperiidae which include nearly 100 endemic species (Varshney and Smetacek 2015, Upadhye et al 2020). Around 328 species are estimated to occur in the state of Tamil Nadu (Pavendhan 2017). The diversity of butterflies depends on plant diversity in a particular area (Padhye et al 2006, Sharmila and Thatheyus 2022). Kanagaraj and Kathirvelu (2018) recorded 52 species and 40 genera of butterflies in the coastal area of Cuddalore District, Tamil Nadu during December 2013 to November 2014. Landscape heterogeneity can also affect the dispersal of butterflies, and non-arable patches across agricultural landscapes are important for butterfly movement, especially for low-mobility species. The impact of land-use interactions on biodiversity patterns has been poorly explored (Bonebrake et al 2019, Hendershot et al 2020). Agricultural intensification is widely accepted as a major cause for biodiversity decline. It is a broad concept encompassing many factors, such as the loss of habitat, fragmentation of ecosystems and increased input of insecticides, pesticides and herbicides. The present study is aimed to examine the assemblage and diversity of butterflies in various ecosystem of Cuddalore district, Tamil Nadu, India.

MATERIAL AND METHODS

The butterflies were observed in the Bhuvanagiri (11.4459° N, 79.6530° E), Chidambaram (11.3921° N, 79.7147° E), Cuddalore (11.7480° N, 79.7714° E), Kattumannarkoil (11.2800° N, 79.5519° E) and Kurinjipadi (11.5642° N, 79.5960° E) in the Cuddalore District from various ecosystems *viz.,* agricultural land, bushy areas, grassland, orchards etc. The data was compiled and classified as agricultural, horticultural and semi-urban ecosystem from each study site. A 2.5 km transect was selected within each ecosystem (i.e., five transects for each ecosystem) at each study site. Each transect was monitored

monthly from March 2022 to February 2023 as per Pollard walk method (Pollard 1977). To characterize diversity along each transect, a catch-and-release method was used during conditions suitable for butterfly activity (i.e., sunny days with wind speeds < 40 km/h between 08:30 AM and 12:00 PM). During surveys, one observer and one recorder walked at a constant pace of 1–1.5 km/h along the transect and recorded and identified all butterflies within 5 m of the transect line. A sweep net was used to capture individual butterflies, if capture was necessary for identification and immediately release after identification. When identification was not possible in the field, photographs were taken to identify the butterflies later. Butterflies were identified up to species level with the aid of relevant field guides and keys (Gunathilagaraj et al 1998, Kehimkar 2016). The status of butterflies was assessed using Treadaway's Checklist (1995). The scale of occurrences was used to evaluate the status of butterflies as very rare (1-3 occurrences), rare (4-10 occurrences), common (11-20 occurrences) and very common (21-above occurrences). The diversity indices namely Dominance (D), Simpson (λ), Shannon-Wiener (H1), Evenness_e^H/S, Brillouin, Menhinick, Margalef, Equitability_J, Fisher_alpha, Berger-Parker and Chao-1 of dominance were analysed with Past version 4.0 (Hammer et al 2001).

RESULTS AND DISCUSSION

The total of 60 species and 44 genera were identified under five families *viz.,* Papilionidae (8 species), Pieridae (9), Nymphalidae (20), Lycaenidae (16) and Hesperiidae (7) were observed in the diverse ecosystems. The highest number of species were recorded in horticultural ecosystem (59 species) followed by semi-urban ecosystem (40) and agricultural ecosystem (38) (Table 1, Fig. 1). The total of 17 species were found to be very common in horticultural ecosystem which comprises bushy areas, grassland, orchards, plantation crops and weeds etc. whereas, the 18 species were recorded very rare in horticultural ecosystem (Table 1). The six species, *D. genutia, E. core, C. pomona, C. pyranthe, E. brigittia* and *L. nina* were found to be very common in semi-urban ecosystem, which mainly feeds on avenue trees, kitchen garden, lawns, ornamental flower plants, parks, etc. The species *G. agammemnon, Chilades pandava, C. putli, Jamides celeno, Prosotas dubiosa, H. bolina M. phedima* and *Psuedocoladenia dan* were recorded very rare in the semi-urban ecosystem. Paul and Sultana (2020) revealed the importance of small green patches of urban and suburban areas in cities serving as a preferred habitat for butterflies. Devi et al (2021) reported that the presence of *Senna siamea* attracts the *Catopsilia pyranthe* butterfly which is commonly found along the roadsides in semi-urban areas.

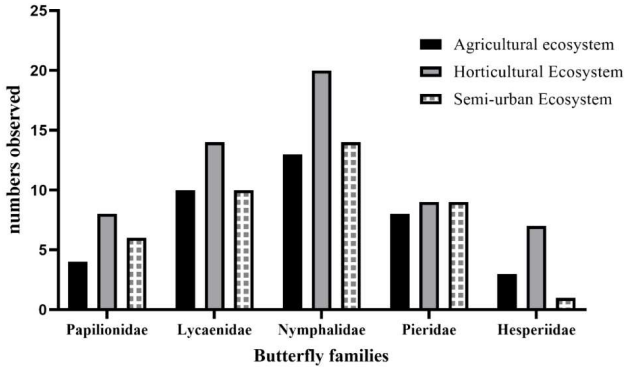

Fig. 1. Population assemblage of butterfly families in diverse ecosystem of Cuddalore district, Tamil Nadu

In agro-ecosystem, the five species, *L. boeticus, M. leda, C. pyranthe, E. brigittia* and *P. mathias* were found to be very common. The species *Pachliopta aristolochiae, P. demoleous, P. polytes, C. putli, Byblia ilithyia, Mycalesis perseus* and *Neptis hylas* were recorded very rare in agricultural ecosystem. Large-sized crop fields cause a homogenization of landscapes and thus increases barrier effects for many butterfly species (Batary et al 2017, Hass et al 2018). Crops such as cereals, cotton, pulses, sesamum, sugarcane, weeds were predominantly found in the agro-ecosystem as these crops are hosts of the above species. Soniya and Palot (2002) observed that the *M. leda* and *P. mathias* were abundant in the vegetative stage of the rice crop. Moorthy et al (2022) reported the blue butterfly (pod borer), *L. boeticus* was known to attack different leguminous vegetables. Kathirvelu et al (2022) documented that the caterpillars of many species of butterflies fed and developed on weed plants, thereby suppressing weeds like milkweeds, knotweed, flannel weed, hogweed on agricultural and horticultural farms. Arya et al (2020) observed that 85.92% male and 14.08% female butterflies were feeding at various sites as puddles, moist soil, mammalian dung and algal mats. However, these feeding sites were primarily found in the agricultural and horticultural farms.

Among the ecosystems, horticultural ecosystem recorded dominance (D) value less than one (0.029) and this indicates more diversity, followed by semi-urban ecosystem (0.037) and agro-ecosystem (0.039). The highest diversity indices of Simpson index (λ) (0.971), Shannon-Weiner (H1) (3.713), Margalef index (8.610) and Menhinick (2.118) were high in horti-ecosystem and this higher index values indicate that the species are more diverse in the horti-ecosystem (Table 2). Karmakar et al (2022) observed that the highest values of Simpson, Shannon and Margalef diversity indices were obtained in the roadside and garden habitat, whereas

Table 1. Inventory of butterfly species in Cuddalore district, Tamil Nadu during 2022-23

Scientific name	Common name	Agricultural ecosystem		Horticultural ecosystem		Semi-urban ecosystem	
		n	SD	n	SD	n	SD
Family: Papilionidae							
Graphium agammemnon	Tailed Jay	0	-	5	R	3	VR
Graphium doson	Common Jay	0	-	1	VR	0	-
Graphium sarpedon	Common Bluebottle	0	-	1	VR	0	-
Pachliopta aristolochiae	Common Rose	2	VR	12	C	5	R
Pachliopta hectar	Crimson Rose	4	R	17	C	11	C
Papilio demoleous	Lime Butterfly	2	VR	25	VC	16	C
Papilio polymnestor	Blue Mormon	0	-	7	R	4	R
Papilio polytes	Common Mormon	1	VR	12	C	9	R
Family: Lycaenidae							
Castalius rosimon	Common Peirrot	11	C	24	VC	14	C
Catochrysops strabo	Forget-Me-Not	4	R	11	C	8	R
Chilades pandava	Plains Cupid	8	R	12	C	2	VR
Chilades putli	Small Grass Jewel	3	VR	12	C	1	VR
Curetis thetis	Indian sunbeam	0	-	1	VR	0	-
Euchrysops cnejus	Gram Blue	15	C	0	-	0	-
Everes lacturnus	Indian Cupid	0	-	2	VR	0	-
Jamides celeno	Common Cerulean	4	R	9	R	2	VR
Lampides boeticus	Pea Blue	31	VC	3	VR	0	-
Prosotas dubiosa	Tailless Line Blue	0	-	4	R	3	VR
Pseudozizeeria maha	Pale Grass Blue	4	R	11	C	14	C
Rapala varuna	Indigo flash	0	-	2	VR	0	-
Spalgis epius	Apefly	0	-	12	C	8	R
Zizeeria karsandra	Dark Grass Blue	9	R	21	VC	11	C
Zizina indica	Lesser Grass Blue	0	-	8	R	6	R
Zizula hylax	Tiny Grass Blue	6	R	14	C	11	C
Family: Nymphalidae							
Acraea violae	Tawny Coster	16	C	28	VC	11	C
Ariadne	Angle Castor	0	-	1	VR	0	-
Ariadne merione	Common Castor	19	C	21	VC	9	R
Byblia ilithyia	Joker	3	VR	12	C	19	C
Danaus chrysippus	Plain Tiger	16	C	26	VC	19	C
Danaus genutia	Striped Tiger	11	C	35	VC	29	VC
Euploea core	Common Crow	8	R	28	VC	21	VC
Euthalia aconthea	Common Baron	0	-	3	VR	0	-
Hypolimnas bolina	Great Eggfly	0	-	3	VR	1	VR
Hypolimnas misippus	Danaid Eggfly	0	-	8	R	0	-
Melanitis leda	Common Evening Brown	21	VC	3	VR	8	R
Melanitis phedima	Dark Evening Brown	7	R	9	R	2	VR
Mycalesis perseus	Common Bushbrown	1	VR	14	C	0	-
Neptis hylas	Common Sailor	2	VR	12	C	9	R

Cont...

Table 1. Inventory of butterfly species in Cuddalore district, Tamil Nadu during 2022-23

Scientific name	Common name	Agricultural ecosystem		Horticultural ecosystem		Semi-urban ecosystem	
		n	SD	n	SD	n	SD
Junonia almanac	Peacock pansy	10	R	21	VC	8	R
Junonia hierta	Yellow Pansy	0	-	1	VR	0	-
Junonia iphita	Chocolate Pansy	8	R	21	VC	11	C
Junonia lemonias	Lemon Pansy	0	-	2	VR	0	-
Junonia orithya	Blue Pansy	0	-	2	VR	0	-
Tirumala limniace	Blue Tiger	8	R	21	VC	12	C
Family: Pieridae							
Catopsilia pomona	Common Emigrant	12	C	24	VC	26	VC
Catopsilia pyranthe	Mottled Emigrant	27	VC	18	C	21	VC
Cepora nerissa	Common Gull	10	R	20	C	8	R
Colotis amata	Small Salmon Arab	19	C	27	VC	7	R
Delias eucharis	Common Jezebel	9	R	24	VC	12	C
Eurema brigittia	Small Grass Yellow	21	VC	41	VC	26	VC
Eurema hecabe	Common Grass Yellow	16	C	43	VC	12	C
Leptosia nina	Psyche	12	C	26	VC	23	VC
Pareronia valeria	Common wanderer	0	-	9	R	10	R
Family: Hesperiidae							
Ampittia dioscorides	Bush hopper	0	-	9	R	0	-
Borbo cinnara	Rice Swift	18	C	2	VR	0	-
Pelopidas mathias	Rice skipper	21	VC	3	VR	0	-
Erionota thrax	Banana skipper	0	-	2	VR	0	-
Potanthus nesta	The Dart	0	-	2	VR	0	-
Psuedocoladenia dan	Fulvous Pied Flat	7	R	11	C	2	VR
Suastus gremius	Indian Palm Bob	0	-	1	VR	0	-

* n- numbers observed; SD- Status of Dominance; As per Treadaway's checklist for the status of dominance, <3: Very Rare (VR); 4-10: Rare (R); 11-20: Common (C); >20: Very Common (VC)

the lowest values were observed in the plantation habitat. However, Evenness_e^H/S (0.805), and Equitability- J (0.941) were recorded maximum, which indicate that the large number of species shared the same distribution proportion in the semi-urban ecosystem and also it shows the stability of the ecosystem (Table 2). Shannon's and Simpson's diversity indices were appropriate for conservation planning when selecting priority sites for protection by ranking them by their level of diversity (Magurran and Dornelas 2010). Berger Parker index (0.076) was maximum in agro-ecosystem and this indicates that the community is dominated by the most common species (*i.e.,* not evenly distributed) *Melanitis leda* (Common evening brown/ rice green horned caterpillar) and *Pelopidas mathias* (Rice skipper) in rice ecosystem (Table 1, 2). Elanchezhyan and Balakrishnan (2020) documented the butterfly pests, *M. leda* and *P. mathias* were found abundant in the vegetative stage of rice fields.

Table 2. Diversity indices of butterfly species in Cuddalore district, Tamil Nadu during 2022-23

Diversity Indices	Agricultural ecosystem	Horticultural ecosystem	Semi-urban Ecosystem
Taxa_S	38	59	40
Individuals	406	750	432
Dominance (D)	0.039	0.029	0.037
Simpson (λ)	0.961	0.971	0.963
Shannon-Weiner (H1)	3.395	3.713	3.446
Evenness_e^H/S	0.784	0.707	0.805
Brillouin	3.220	3.566	3.275
Menhinick	1.886	2.118	1.876
Margalef	6.160	8.610	6.262
Equitability_J	0.933	0.914	0.941
Fisher_alpha	10.26	14.67	10.40
Berger-Parker	0.076	0.057	0.067
Chao-1	38.25	59.88	39.25

CONCLUSION

Butterfly communities in different ecosystems of Cuddalore district, Tamil Nadu, India are well supported by abundant crop, floral and weed diversity in horticultural and semi-urban ecosystems than the agro-ecosystem. The number of species of butterflies observed in horticultural ecosystem was consistently greater than both the semi-urban and Farmland habitat. The family Nymphalidae was the most abundant species and had the highest individual species, and the family Hesperiidae recorded the least number of species. Long term monitoring is needed for analysis of butterfly population trends in the coastal area. Furthermore, additional work is needed to compare butterfly beta diversity among general categories of vegetation types within and among different ecosystems, to provide better baseline data.

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