



Survey and diversity of butterfly species in the nagamallai foothills, madurai district, Tamil Nadu, India

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Abstract

A comprehensive study on butterfly diversity was conducted in the Nagamallai Foothills, Madurai District, Tamil Nadu, from August 2020 to November 2022. A total of 69 butterfly species were recorded, belonging to five families: Nymphalidae (30.43%), Pieridae (26.08%), Lycaenidae (24.67%), Hesperidae (10.14%), and Papilionidae (8.9%). Dominant species observed included *Euploea core*, *Junonia lemonias*, *Junonia iphita*, *Danaus chrysippus*, *Melanitis leda*, and *Chilades pandava*. The study highlights the ecological significance of the Nagamallai Foothills as a butterfly habitat and emphasizes the urgent need for habitat restoration and conservation of its shrubland ecosystems. Species richness, diversity indices Simpson's and Shannon-Wiener, dominance, and evenness were statistically analyzed to understand community structure. The findings provide a baseline for future biodiversity monitoring and restoration strategies in the region.

Keywords: Butterfly, nagamalai hills, diversity, pollinators, shannon index

Introduction

Butterflies are ecologically significant as pollinators, indicators of environmental health, and contributors to biodiversity. Their sensitivity to habitat changes makes them valuable bioindicators for monitoring ecosystem stability and degradation. Biodiversity is the variety of life describing the number and variability in relation to ecosystem in which they occur. Insects comprise more than half of the world's known animal species (Wilson, 1992) [38] of which the second largest and more diverse order is Lepidoptera of class Insecta (Benton, 1995) [3]. Insect fauna are the extremely important component of the bio-indicators of the World (Chakaravarthy *et al.*, 1997 [7]; Jana *et al.*, 2009) [13].

Butterflies are taxonomically well studied group, which have received a reasonable amount of attention throughout the world (Ghazoul 2002). Indian butterflies reported are one fifth of total amount of the world butterfly species (Kunte, 2000) [19]. There are 18,000 species of butterflies in the world and India harbors about 1501 butterfly species have been recorded from India (Kunte, 2000; Kehimkar, 2008) [14, 19], 350 species are from Peninsular India, 331 species from the Western Ghats and 313 species of butterflies from South India (Gaonkar, 1996) [9], of which 45 species are endemic to south India (Thomas, 1984). The butterfly fauna is very rich in the Southern part of Peninsular India due to the availability of diverse habitats, a wide range of altitudinal gradients and associated microclimate regimes (Kunte, 2000) [19].

Butterflies serve as vital components of ecosystems, fulfilling ecological, economic, and aesthetic roles. Ecologically, they function as pollinators and, in some cases, as herbivores or minor pests of agricultural crops (Anbalagan *et al* 2021) [1]. Their sensitivity to environmental changes also makes them valuable bioindicators for monitoring habitat quality and biodiversity. Consequently, a comprehensive understanding of their taxonomy, biology, and ecological preferences is essential for their effective

conservation and management. Butterflies depend on specific environmental conditions, including suitable microclimates, the presence of larval host plants, and abundant nectar sources. These ecological requirements significantly influence their species richness and community structure, and any disturbance to these factors may result in changes in butterfly populations and diversity (Anbalagan *et al* 2018).

Several factors contribute to the decline in butterfly populations, including habitat destruction, overgrazing, and road development, pesticide use in agriculture, climate change, and scarcity of food resources. Among these, urbanization has emerged as a major driver of habitat loss worldwide, significantly impacting butterfly diversity. Rapid urban development leads to the fragmentation and degradation of natural habitats, disrupting ecological balance and reducing the availability of essential resources for butterfly survival. As a result, many species are now facing increased threats to their persistence. According to Malagrino (2008) [22], the reduction in both the area and quality of natural habitats due to urban expansion has been directly linked to the decline in overall biodiversity.

Studies on butterfly diversity are crucial for understanding the health and status of ecosystems, particularly in the context of increasing anthropogenic pressures on natural resources. Reliable biodiversity assessments are essential for conservation planning and sustainable resource management (Kremen, 1992) [15, 16]. Research has shown that habitat structure significantly influences butterfly diversity. For instance, Lien van Vu (2009) [20] observed that forest edges, which receive greater exposure to sunlight and are structurally more open, tend to support higher butterfly diversity compared to denser forest interiors. Similarly, Bhandari, S, (2021) [5] and Lien van Vu *et al.* (2011) [21] reported that natural openings within forests, such as stream and river corridors, exhibit greater butterfly richness than closed canopy areas, emphasizing the importance of habitat heterogeneity in supporting diverse butterfly communities

Despite its ecological value, limited studies have been conducted on the butterfly diversity in the Nagamalai Foothills. This study aims to fill this gap by documenting the butterfly species richness, composition, and distribution in the region. Additionally, it provides a preliminary assessment of community structure through quantitative measures such as diversity indices, dominance, and evenness. The findings are intended to support future conservation strategies and promote restoration of the shrubland habitat

Materials and Methods

Study area

The study was conducted in the foothills of Nagamalai, located approximately 10 km west of Madurai city, Tamil Nadu, India, along the Madurai-Theni highway and the Vaigai River (Figure 1). The Nagamalai hill range stretches from Nagamalai Pudukottai to Kalluthu, covering about 35.3 km. The area, situated at 9.96088° N latitude and 78.1062° E longitude, includes a mix of agricultural and

forested lands, with anthropogenic disturbances. The region receives significant rainfall during the northeast and southwest monsoons. For sampling, the study area was divided into three transects: (1) Vikkramanagalam, (2) Panniyan Valley, and (3) Uthupatty.

The study areas (1-Vikkramanagalam, 2-Panniyan Valley and 3-Uthupatty) are differing in their habitat characteristics. Vikkramanagalam is being dominated by shrubs, grasslands, and trees, with significant human pressure coming from transportation and overgrazing, and is including a pond surrounded by agricultural lands. Panniyan Valley is being fragmented with shrubs, thorny plants, and trees, with more human intervention occurring due to the nearby Sholavandan-Thirumangalam road and Panniyan village. The surrounding agricultural and horticultural fields are providing rich nectar resources. Uthupatty, on the other hand, is remaining relatively undisturbed by human activity, being characterized by dense native vegetation and grasslands dominated by *Senna auriculata* (avaram plant).

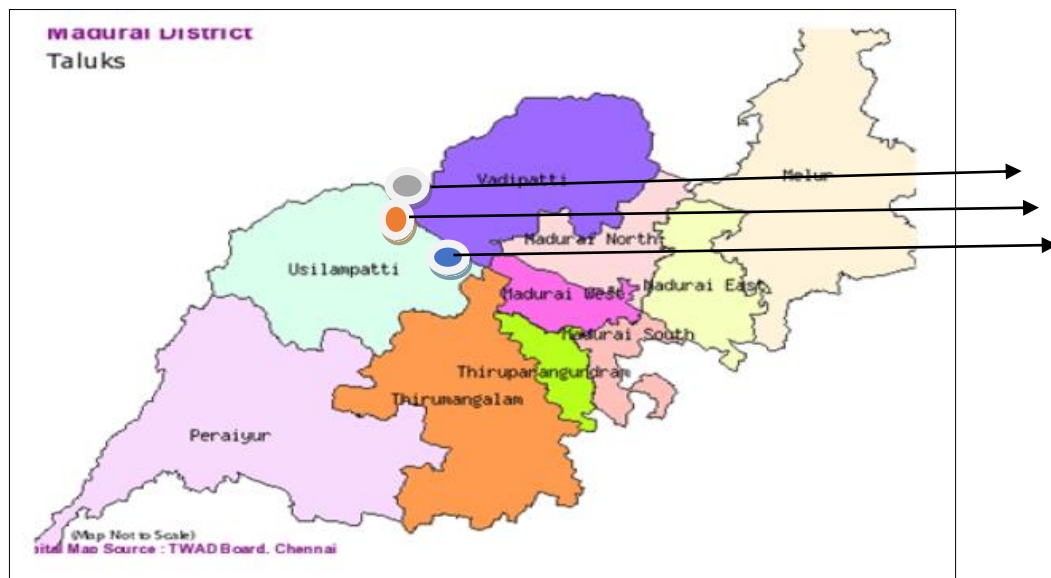


Fig 1: The entire stretch of Nagamalai Hill, Madurai

Inventory (Qualitative estimation)

The assessment of butterfly faunal diversity in the foothills of Nagamalai was conducted through fortnightly observations from August 2020 to November 2022. Field surveys were performed at three distinct locations within the foothills, representing different habitats, where various butterfly species were encountered. Species identification was achieved through photographic documentation, with confirmation of species status carried out using the identification manuals by Gunathilagaraj *et al.* (1998), Kunte (2000)^[19], and Jahir Hussain *et al.* (2010).

Line transect count (Quantitative estimation)

Butterflies were sampled from August 2020 to November 2022 using a modified version of the line-transect count method outlined by Kunte, (1997)^[17]. A permanent line transects, 200 meters in length with a 5-meter width on either side (both in front and above the observer), was established in each of the three transect areas within the foothills. Butterfly species and their abundance were recorded while traversing each transect slowly at a uniform pace for 20 minutes during favorable weather conditions.

The line-transect counting method is widely recognized and accepted as an effective technique for monitoring butterfly population abundance. Its reliability for estimating butterfly numbers has been validated in previous studies (Pollard, 1977; Pollard and Yates, (1993); Ishii, 1996; Natuhara *et al.*, 1996, Gaurav Sharma,2009)^[10]. This method has also been successfully adopted for surveying butterflies across various habitats (Forister ML, *et al.*, 2003; Iindhu,2023)^[11].

Data Recording, Identification and statistical analysis

Each recorded individual was categorized according to its family and species. Identification was confirmed using standard taxonomic references. Abundance data were compiled, and species were classified into their respective families: Nymphalidae, Pieridae, Lycaenidae, Hesperidae, and Papilionida. The butterfly community structure was assessed using PAST software (version 4.03). The analysis included calculating Species Richness (S) to determine the number of species, Shannon-Wiener Index (H') for overall diversity, Simpson's Dominance Index (D) to identify dominant species, and Pielou's Evenness Index (E) to measure the uniformity of species distribution. These

indices provided insights into species diversity and community composition across the study area.

Result and Discussion

A total of 69 butterfly species belonging to five families such as Nymphalidae, Pieridae, Lycaenidae, Hesperidae, and Papilionidae were recorded in the survey conducted in the foothills of Nagamalai, Madurai District, Tamil Nadu, India. Among these families, Nymphalidae (21 Species) was the most dominant, comprising 30.43% of the total species observed, followed by Pieridae (18 Species and 26.09%), Lycaenidae (17 Species and 24.64%), Hesperidae (7 Species and 10.14%), and Papilionidae (6 Species and 8.70%). The dominance of Nymphalidae aligns with patterns documented in similar studies from southern India, where this family is particularly prevalent in forest-edge and open habitats. This suggests that Nymphalidae can serve as a reliable indicator of moderate habitat quality and plant diversity (Bhagat *et al.*, 2019; Rajagopal *et al.*, 2020) [4, 29].

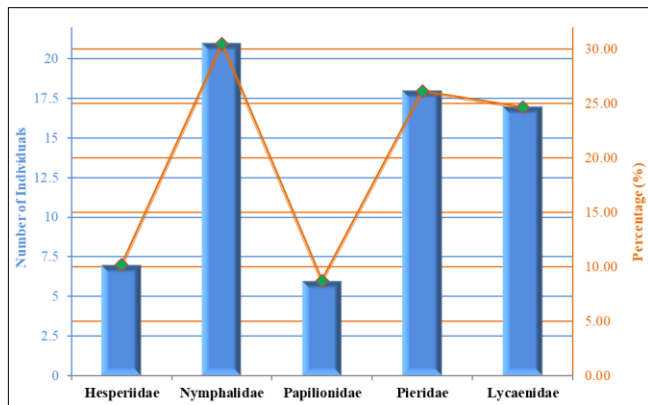


Fig 2: Number of individuals and Percentage composition of Butterfly Families

Butterfly species were categorized based on their abundance in the foothills of Nagamalai, Madurai District, Tamil Nadu, India. The “Common” category had recorded the highest number, with 21 species, followed by “Not Rare” and “Very Common”, which comprised 17 and 15 species respectively. These three categories together constituted the majority of the observed butterfly community, suggesting a dominance of generalist and adaptable species that had been well-suited to the local habitat conditions. In contrast, the “Rare” category included 14 species, implying the presence of butterflies with more restricted distributions or specific

ecological requirements. The “Very Rare” category, which accounted for only 2 species, likely reflected either extreme habitat specialization or very limited population sizes. These species appeared to be of potential conservation concern and thus warranted further study (Figure 3 and Table 1). For example, species like *Gomalia elma* (African marbled skipper) and *Appias albino* (Common albatross) point to the presence of specific larval host plants and relatively undisturbed ecological niches (Kumar *et al.*, 2019;)

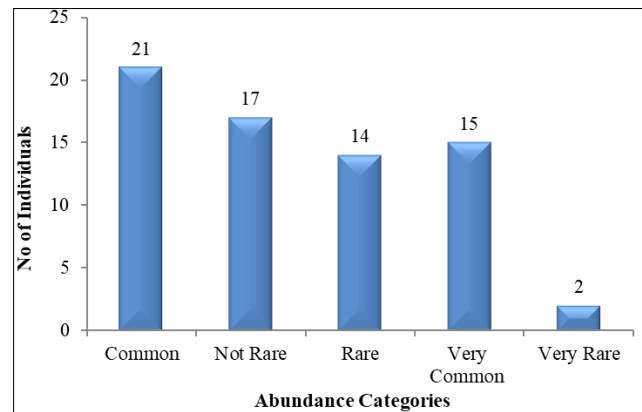


Fig 3: Abundance Categories of Butterfly species in the study area

Additionally, several Lycaenidae species recorded in this study are known to rely on mutualistic relationships with ants and stable microclimates, underscoring the ecological importance of Nagamalai’s habitat for such species (Priyadarshini *et al.*, 2021 [27]; Jain *et al.*, 2023) [12]. This highlights the role of ecotones in providing both nectar resources and breeding habitats, which are essential for butterfly diversity (Thomas and Joseph, 2023 [33]; Bharathi *et al.*, 2022 [6], Watt, 2003) [37]. Raja rajeshwari, (2017) [28] reported that 42 species in belonging five families in arounding Tiruchengode Taluk, Namakkal district. The distribution of butterflies in a location was seen to be closely related to the habitats present in the hotspot (Vikas Madhav, *et al.*, 2020) [36]. The relatively low pollution levels and sustained vegetative cover in parts of the Nagamalai foothills, particularly along riparian zones, appear to support the persistence of habitat-indicator species. These findings are consistent with similar riparian butterfly assessments conducted in other parts of southern India, including the Western and Eastern Ghats (Murugesan *et al.*, 2016; Das and Gupta, 2021) [8, 24].

Table 1: Check list of butterfly species from the foothills of Nagamalai, Madurai District, Tamil Nadu, India

SL No	Family:	Common Name	Scientific Name	Status
1	Hesperidae	African marbled skipper	<i>Gomalia elma</i> (Moore, 1879)	VR
2		Bush hopper	<i>Ampittia dioscorides</i> (Fabricius, 1793)	R
3		Common banded awl	<i>Hasora chromus</i> (Cramer, [1780)	R
4		Common grass dart	<i>Taractrocerma maevius sagara</i> (Moore, 1866)	R
5		Indian grizzled skipper	<i>Spialia galba galba</i> (Fabricius, 1793)	C
6		Small branded swift	<i>Pelopidas mathias</i> (Fabricius, 1798)	R
7		Rice swift	<i>Borbo cinnara</i> (Wallace, 1866)	R
8	Nymphalidae	Angled castor	<i>Ariadne araiadne</i> (Moore, 1884)	R
9		Blue pansy	<i>Junonia otithya</i> (Linnaeus, 1758)	VC
10		Blue tiger	<i>Tirumala limniace</i> (Cramer, 1775)	NR
11		Chocolate pansy	<i>Junonia iphita</i> (Cramer, [1779)	C
12		Common baron	<i>Euthalia aconthea</i> (Moore, [1858)	R
13		Common Bush brown	<i>Mycalesis perseus</i> (Fabricius, 1793)	R

14		Common castor	<i>Ariadne merione</i> (Cramer, 1777)	C
15		Common evening brown	<i>Melanitis leda</i> (Linnaeus, 1758)	R
16		Common five ring	<i>Ypthima baldus</i> (Fabricius, 1775)	NR
17		Common four ring	<i>Ypthima huebneri</i> (Kirby, 1871)	NR
18		Common Indian crow	<i>Euploea core</i> (Cramer, 1780)	C
19		Common leopard	<i>Phalanta phalantha</i> Drury, [1773]	VC
20		Common Sailor	<i>Neptis hylas</i> (Linnaeus, 1758)	VC
21		Danaid eggfly	<i>Hypolimnas misippus</i> (Linnaeus, 1764)	NR
22		Dark blue tiger	<i>Tirumala septentrionis</i> (Butler, 1874)	R
23		Great eggfly	<i>Hypolimnas bolina</i> (Linnaeus, 1758)	NR
24		Lemon Pansy	<i>Junonia lemonias</i> (Linnaeus, 1758)	VC
25		Peacock pansy	<i>Junonia almanac</i> (Linnaeus, 1758)	R
26		Plain tiger	<i>Danaus chrysippus</i> (Linnaeus, 1758)	C
27		Tawny coster	<i>Acraea terpsicore</i> (Linnaeus, 1758)	VC
28		White four ring	<i>Ypthima ceylonica</i> (Hewitson, 1865)	VC
29	Papilionidae	Blue mormon	<i>Papilio polymnestor</i> (Cramer, 1775)	R
30		Common mormon	<i>Papilio polytes</i> (Linnaeus, 1758)	C
31		Common rose	<i>Pachliopta aristolochiae</i> (Fabricius, 1775)	NR
32		Crimson rose	<i>Atrophaneura hector</i> (Linnaeus, 1758)	C
33		Lime butterfly	<i>Papilio demoleus</i> (Linnaeus, 1758)	NR
34		Tailed jay	<i>Graphium Agamemnon</i> (Linnaeus, 1758)	R
35	Pieridae	Common albatross	<i>Appias albino</i> (Boisduval, 1836)	VR
36		Common emigrant	<i>Catopsilia pomona</i> (Fabricius, 1775)	NR
37		Common grass yellow	<i>Eurema hecabe</i> (Linnaeus, 1758)	VC
38		Common gull	<i>Cepora nerissa</i> (Fabricius, 1775)	VC
39		Common jezebel	<i>DeDelias eucharis</i> (Drury, 1773)	VC
40		Common wanderer	<i>Pareronia valeria</i> (Cramer, 1776)	VC
41		Crimson tip	<i>Colotis danae</i> (Fabricius, 1775)	NR
42		Great orange tip	<i>Hebomoia glaucippe</i> (Linnaeus, 1758)	NR
43		Mottled emigrant	<i>Catopsilia pyranthe</i> (Fabricius, 1793)	C
44		Pioneer	<i>Belenois aurota</i> (Fabricius, 1793)	VC
45		Plain orange tip	<i>Colotis aurora</i> (Fabricius, 1793)	C
46		Psyche	<i>Leptosia nina</i> (Fabricius, 1793)	VC
47		Small grass yellow	<i>Eurema brigitta</i> (Wallace, 1867)	VC
48		Small orange tip	<i>Colotis etrida</i> (Boisduval, 1836)	NR
49		Small salmon arab	<i>Colotis amata</i> (Fabricius, 1775)	NR
50		Three spot grass yellow	<i>Eurema blanda</i> (Boisduval, 1836)	VC
51		White orange tip	<i>Lxias Marianne</i> (Cramer, 1779)	NR
52		Yellow orange tip	<i>Lxias pyrene</i> (Linnaeus, 1764)	C
53	Lycaenidae	Common Cerulean	<i>Jamides celeno</i> (Cramer, 1775)	C
54		Common line blue	<i>Prosotas nora</i> (Felder, 1860)	C
55		Common pierrot	<i>Castalius rosimon</i> (Fabricius, 1775)	NR
56		Dark grass blue	<i>Zizeeria karsandra</i> (Moore, 1865)	C
57		Gram blue	<i>Euchrysops cnejus</i> (Fabricius, 1798)	C
58		Lesser grass blue	<i>Zizina otis</i> (Fabricius, 1787)	C
59		Lime blue	<i>Chilades lajus</i> (Stoll, 1780)	C
60		Oriental forget me not	<i>Catochrysops Strabo</i> (Fabricius, 1793)	NR
61		Oriental grass jewel	<i>Freyeria trochylus</i> (Freyer, 1845)	VC
62		Pale grass blue	<i>Pseudozizeeria maha</i> (Kollar, [1844])	C
63		Pea blue	<i>Lampides boeticus</i> (Linnaeus, 1767)	C
64		Plains cupid	<i>Chilades pandava</i> (Horsfield, 1829)	C
65		Small cupid	<i>Chilades parrhasius</i> (Fabricius, 1793)	NR
66		Stripped pierrot	<i>Tarucus nara</i> (Kollar, 1848)	C
67		Tailless lime blue	<i>Prosotas dubiosa</i> (Semper, 1879)	R
68		Tiny grass blue	<i>Zizula hylax</i> (Fabricius, 1775)	NR
69		Zebra blue	<i>Tarucus plinius</i> (Fabricius, 1793)	C

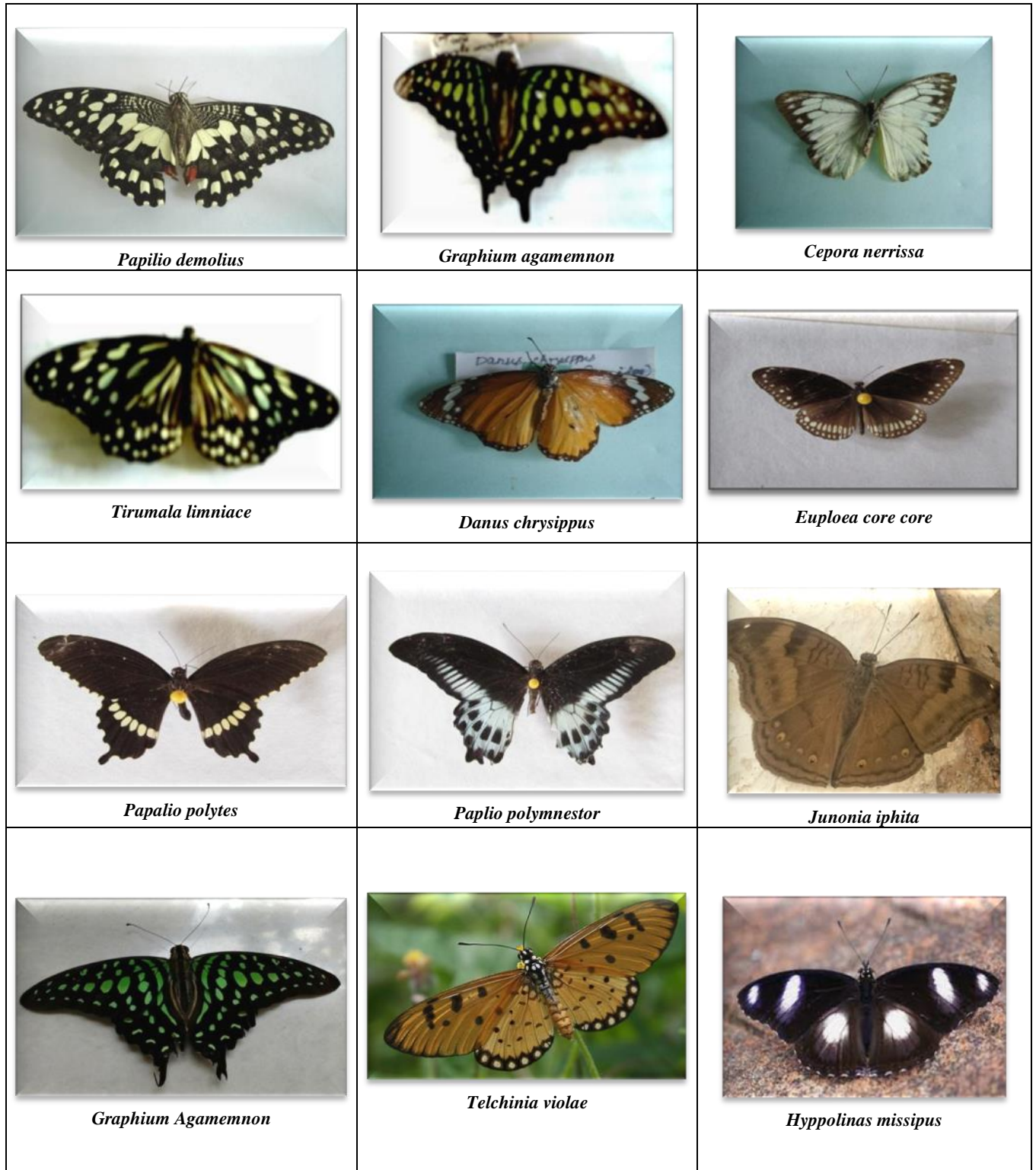
Table 2. showed a gradual increase in biodiversity was observed during the study period from August 2020 to December 2022, as evidenced by the rise in the total number of taxa from 59 in 2020 to 65 in 2022, along with an increase in the total number of individuals from 123 to 229. The Simpson's Diversity Index (1-D) showed a slight increase from 0.7774 to 0.7924, while the Shannon Diversity Index (H') also rose marginally from 1.556 to 1.59, indicating a moderately diverse and stable community.

Richness indices, including Margalef (R1) and Menhinick (R2), showed a slight decline, which was likely due to the disproportionate rise in individual abundance compared to species richness. Evenness indices, such as e^H/S and Pielou's Equitability (J), remained consistently high and showed a slight upward trend, suggesting a more balanced distribution of individuals among species. Furthermore, the Dominance Index (D) decreased from 0.2226 to 0.2076, reflecting a reduction in the dominance of a few taxa.

Table 2

Parameters	August-2020 To December-2020	January -2021 to December-2021	January-2022 to December-2022
Total Numbers of Taxa	59	60	65
Total No. of Individuals	123	169	229
Simpson Index _{1-D}	0.7774	0.7939	0.7924
Shannon Diversity H'	1.556	1.593	1.59
Margalef(R1)	0.981	0.977	0.9582
Menhinick (R2)	0.6509	0.6455	0.6202
Evenness _{e^H/S}	0.9477	0.9835	0.9808
Equitability _J	0.9666	0.977	0.988
Dominance _D	0.2226	0.2061	0.2076

Plate 1: Butterfly fauna collected from Nagamalai foothills from Madurai District



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COMPETING INTERESTS:

Authors have declared that no competing interests exist.

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