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A preliminary assessment of diversity and abundance of butterfly (Insecta: Lepidoptera) fauna in Barbara forest, Odisha, India

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Abstract
A study on butterfly diversity and abundance was carried out in the Barbara Forest, Odisha in the month of December 2024. The tropical deciduous forests support a variety of flora and fauna, including butterflies. The study recorded the presence of 69 butterflies belonging to six different families and 52 different genera. Maximum number of butterflies were recorded from family Nymphalidae (54.68%) followed by Pieridae (18.23%), Lycaenidae (17.47%), Papilionidae (6%), Hesperiidae (3.30%) and lastly Riodinidae (0.32%). On the basis of sightings of butterflies, 39.48% belonged to not rare category, 29.64% belonged to very common category, 16.39% belonged to common category, 14.06% belonged to rare category and 0.43% belonged to very rare category. 13 butterfly species among the recorded butterfly species were legally protected under various schedules of the Wildlife protection Act, 1972. Values of different diversity indices such as Shannon diversity index (H'= 3.79), illustrated the high species richness of the butterfly community. Pielou's evenness index (j=0.90) depicted the evenly distributed nature of the recorded butterfly species. Simpson's index of diversity (D= 0.97) which indicated the persistence of high species abundance in the butterfly community. Thus, information from this preliminary survey will prove to be helpful towards conservation of the forest habitat as well as the butterfly fauna residing in the forest.

Keywords: Barbara Forest, butterfly community, diversity indices, Nymphalidae, species richness.

Introduction

Butterflies, a taxonomic group of highly diverse insects of order Lepidoptera are closely studied globally because of their short lifespan, ability to adapt to a variety of microclimate conditions, and rapid reaction to environmental cues (Nowicki *et al*., 2013; Schmucki *et al*., 2016; MacDonald *et al*., 2017) [23] [30] [16]. They are recognized by their size, shape and magnificent color patterns of wings. They are not only visually attractive but also an essential component of ecosystems, due to their vital role in ecosystem functioning, serving as one of the primary ecological indicators, powerful pollinators, a food source, integrant of food chain and proxy taxa for determining the health and conservation status of a habitat (Kocher and Williams, 2000; Kunte, 2000; Sawchik *et al*., 2005; Hayes *et al*., 2009) [13] [14] [29] [9]. There exists six families of order Lepidoptera, namely Papilionidae, Pieridae, Lycaenidae, Nymphalidae, Hesperiidae and Riodinidae.

Approximately, 18,768 butterfly species have been documented globally (Van Nieukerken *et al*., 2011) [38], nearly 80% of them are reported from tropical areas. India hosts about1318 species of butterflies, among them 461 species belong to Nymphalidae, 89 species belong to Papilionidae, 92 species belong to Pieridae, 380 species belong to Lycaenidae, 19 species belong to Riodinidae and 277 species belong to Hesperiidae (Cotton *et al*., 2015; Kehimkar, 2016) [6] [11]. About 100 species from India are endemics (Tiple *et al*., 2006) [35]. Nearly 177 butterfly species were recorded from the former Central Provinces of central India (now Madhya Pradesh, Chhattisgarh, and Vidarbha), 351 species from Peninsular India (Tiple, 2011) [36]. Over the past ten years, studies on butterfly diversity were carried out in different region of state Odisha, India. Approximately 200 species of butterflies have been documented from this state (Singh *et al*., 2020) [34]. About 170 species were reported from Bonai Forest Division (Mohapatra *et al*., 2012) [19], 50 species from Gudgudia range of Simipal Tiger Reserve (Sethy and Jena, 2009) [31], 188 species from Similipal Tiger Reserve Nair (2011) [22], 136 species from fringe areas of Similipal Biospehere Reserve (Payra *et al*., 2016) [25], 93 species from Nandankanan Wildlife Sanctuary (Mishra *et al*., 2010) [18],101 species from Sunabeda Wildlife Sanctuary (Palei and Rath, 2014) [24], 63 species from the campus of Utkal University (Mohapatra *et al*., 2013) [20] and 101 species from the campus of Regional Institute of Education in Bhubaneswar (Priyamvada and Mohapatra, 2016) [27].

Eastern Ghats, a discontinuous chain of mountain range, stretching along India's eastern coast through the states of Odisha, Andhra Pradesh and Tamil Nadu (Behera *et al*., 2024) [2] is enriched with incredible diversity of butterflies (Gunathilagaraj *et al*., 1998) [8]. Barbara Forest, a nature reserve, is a part of the Eastern Ghats Mountain range. This patch of forest located in Khordha district, Odisha, India. The forest vegetation was dominated by sal tree along with Piasal, Ficus, Arjun, Ashoka and Kasi, etc. Though having a highly diverse floral composition, no studies have been conducted on butterfly diversity in Barbara Forest, an attempt was undertaken to enumerate the diversity and abundance of butterfly fauna in Barbara Forest, Khorda, Odisha, through this present study.

Materials and Methods

Study Area

The present study was conducted in the Barbara Forest, located near Chilika Lake in coastal Odisha. The study area covered a distance of about 5 km from Barbara Nature Camp (19.84882°N, 85.02369°E) to Hatigada Waterfall (19.88289°N, 85.03184°E). Barbara Forest and its adjoining areas typically experience a tropical climate with average

annual maximum temperature of 31.4°C and minimum temperature of 21.04°C. The average rainfall experienced this area is about 161.71mm, with the monsoon season spanning from June to September.

Survey Technique

Data collection was conducted during the month of December, 2024 when the climate was moderate and pleasant with neither heavy rain nor heavy wind. Simple observation methods were utilized, either via naked eyes or via binocular, and photographs. For the purpose of butterfly sampling, the line transect method was implemented (Hossain and Aditya, 2016) [10]. The entire survey was done adopting the standard Pollard Walk methodology, along the forest path with 5 m on either side for five hours maintaining a constant pace between 10:30 h to 15:30 h. In order to cover the entire survey path of about 5 km, a total number of ten transects, each with 500 m of length were surveyed per day. The sampling was carried out for consecutive seven days and each sampling followed the same transect path to minimize the number of variables (Pyle, 1992) [28]. All the butterfly species observed during the sampling period were recorded along with their number.

Most of the butterfly species were identified by direct observation in the field or in few difficult cases photographs were clicked and identification was done by following the keys of Kunte *et al*. (2014) [15], Kehimkar (2016) [11], and Dey *et al*. (2017) [7]. During the course of the study, the butterflies were neither collected nor captured. All the common English names and scientific names followed in the study were in accordance with Varshney and Smetacek (2015) [39].

Statistical data Analysis

To understand the community structure of the butterfly species in the sampled site, all the recorded data were used to estimate the diversity indices with the help of Microsoft Excel 2019 software. Species richness, abundance and evenness were determined through Shannon index (Shannon and Weaver, 1963) [32], Simpson index (Simpson, 1964) [33] and Pielou's index (Mulder *et al*., 2004) [21] respectively. To explain species richness and evenness a rank abundance curve was prepared (Whittaker, 1965) [40].

Shannon diversity index (H') = - Σ pi ln pi

Shannon H_{max}= Log_1 (N)

Dominance index (D_{BP})= ni/N (Berger and Parker, 1970) [3]

Simpson's diversity index (Ds)= Σ^{S}_{i-1}[ni (ni-1)/N(N-1)]

Simpson's index of diversity (D)= 1-Σ^{S}_{i-1}[ni (ni-1)/N(N-1)]

Simpson's reciprocal index (Dr)= 1/ Σ^{S}_{i} pi^2

Pielou's evenness index (J')= H'/ln N

Here, pi is the proportion of the i^{th} species in the butterfly community. N is the number of species present in a butterfly fauna. ni is the number of individuals of i^{th} species.

Result

Map of Odisha, vegetation of Barbara Forest and satellite image of study site is represented in figure 1. Table 1 illustrates the checklist of the butterfly species recorded during the survey period along with the family they belong to, as well as their relative abundance and WPA Schedule (Wildlife Protection Act, 1972). The survey recorded the presence of 69 different butterfly species belonging to six families and 52 different genera. The most common butterfly sampled from the study site was Quaker (*Neopithecops zalmora*; RA-6.65), followed by Common Evening Brown (*Melanitis leda*; RA-6.22), Common Bushbrown (*Mycalesis perseus*; RA-5.68), Common Emigrant (*Catopsilia pomona*; RA-5.62), Common Fourring (*Ypthima huebneri*; RA-5.46), Mottled Emigrant (*Catopsilia pyranthe*; RA-4.38), and Common Sailer and Lemon Pansy (*Neptis hylas* and *Junonia lemonias* respectively; both with RA-3.14). It was recorded that the relative abundance of nine butterfly species was ranged from 3.00 to 2.00, namely Chocolate Pansy (*Junonia iphita*; RA-2.97), Common GrassYellow (*Eurema hecabe*; RA-2.76), Common Pierrot (*Castalius rosimon*) and Grey Pansy (*Junonia atlites*) both with RA- 2.43, Tawny Coster (*Acraea terpsicore*; RA-2.33), Baronet (*Symphaedra nais*; RA-2.22), Common Cerulean and Common Fiverring (*Jamides celeno* and *Ypthima baldus* respectively; both with RA- 2.11) and Common Leopard (*Phalanta phalantha*; RA-2.00). Whereas, relative abundance of thirteen species were found between 2% to 1%, namely Common Gull (*Cepora nerissa*; 1.84%), Lime butterfly (*Papilio demoleus*; 1.68%), Common Mormon and Plain Tiger (*Papilio polytes* and *Danaus chrysippus* respectively; both with 1.57%), Angled Castor and Common Crow (*Ariadne ariadne* and *Euploea core* respectively; both with 1.51%), Striped Pierrot (*Tarucus nara*; 1.35%), Common Castor, Eggfly and Tailed Jay (*Ariadne merione*, *Hypolimnas bolina* and *Graphium agamenon* respectively; all with 1.30%), Palmfly (*Elymnias hypermnestra*; 1.24%), lastly Angled Pierrot and Common Sergeant (*Caleta decidia* and *Athyma perius* respectively; both with 1.03%). The relative abundance of rest of the butterflies at the study site was less than 1.

Tawny Rajah (*Charaxes polyxena*) and Common Lascar (*Pantoporia hordonia*) belonging to the Nymphalidae family were counted only one in number, therefore considered as the rarest butterfly species of the study site.

While considering the family Nymphalidae, Common Evening Brown (*Melanitis leda*) was found as most abundant butterfly species, followed by Bushbrown (*Mycalesis perseus*) and Common Fourring (*Ypthima huebneri*) while, the less counted butterflies were Common Lascar (*Pantoporia hordonia*) and Tawny Rajah (*Charaxes polyxena*).When the Papilionidae family was taken into consideration, Lime butterfly (*Papilio demoleus*) was counted with maximum number, while Blue Mormon (*Papilio polymnestor*) with least number. Under the family Pieridae, Common Emigrant (*Catopsilia Pomona*) was found to be the most abundant butterfly species, followed by Mottled Emigrant (*Catopsilia pyranthe*), whereas the least abundant butterfly belonging to this family was Striped Albatross (*Appias libythea*). Under family Lycaenidae, Quaker (*Neopithecops zalmora*) was the most abundant butterfly species and Zebra Blue (*Leptotes plinius*) was the least abundant one, observed at the study site. In the family Hesperiidae, Indian Skipper (*Spialia galba*) was the most counted butterfly species and Grass Demon (*Udaspes folus*) was the least counted one. In the present study area, Plum Judy (*Abisara echerius*) was the only butterfly species belonging to the family Riodinidae.

The results of percentage composition of the six butterfly families were shown in figure 2(i). It was observed that maximum number of butterflies belonged to family Nymphalidae (54.68%) followed by Pieridae (18.23%), Lycaenidae (17.47%), Papilionidae (6%), Hesperiidae (3.30%) and lastly Riodinidae (0.32%).

Genus proportion analysis (figure 2ii) illustrated that maximum number of genera were found in the family Nymphalidae, comprised of 22 genera (42.31%), followed by Lycaenidae with 11 genera (21.15%), Hesperiidae and Pieridae both with 8 genera (15.38%), Papilionidae with 2 genera (3.85%) and only 1 genus was recorded from family Riodinidae (1.95%). While considering the species proportion analysis, it was observed that maximum number of species belonged to family Nymphalidae (46.38%) followed by Lycaenidae (17.39%), Pieridae (14.49%), Hesperiidae (11.59%), Papilionidae (8.70%) and lastly Riodinidae (1.45%).

The butterflies recorded from the survey site were categorized into five classes based on their prevalence, namely very common (VC), common (C), not rare (NR), rare (R) and very rare (VR). The result was displayed in figure 4. The study portrayed that among the total number of butterfly species reported from the study site, 39.48% belonged to NR category, 29.64% belonged to VC category, 16.39% belonged to C category, 14.06% belonged to R category and lastly 0.43% belonged to VR category.

Most of the butterfly species sampled at the study site were 'common' and 'generalist species' and none of them were universally threatened according to IUCN Red List (Ver. 3.1). Only 13 butterfly species, observed at the study site, were found to be protected under various Schedules of the Wildlife Protection Act, 1972. Among these butterfly species, two of them are protected under Schedule I namely, Common Mime (*Papilio clytia*) and Common Pierrot (*Castalius rosimon*), ten of them are protected under Schedule II namely, White-bar Bushbrown (*Mycalesis anaxias*), Striped Tiger (*Danaus genutia*), Common Earl (*Tanaecia jahnu*), Tawny Rajah (*Charaxes polyxena*), Common Gull (*Cepora nerissa*), Angled Pierrot (*Caleta decidia*), Striped Pierrot (*Tarucus nara*), Pea Blue (*Lampides boeticus*), Plum Judy (*Abisara echerius*) and Snow Flat (*Tagiades japetus*). Only 1 butterfly is protected under schedule IV namely, Striped Albatross (*Appias libythea*).

Figure 2(iii) illustrates the species richness of the butterfly genera found in the study site. It was observed that the genus *Junonia* and *Mycalesis* of family Nymphalidae, the genus *Papilio* of family Papilionidae were the dominant genus with four species, namely *Junonia atlites, Junonia lemonias, Junonia almana, Junonia iphita* under the genus *Junonia, Mycalesis mineus, Mycalesis visala, Mycalesis perseus, Mycalesis anaxias* under the genus *Mycalesis* and *Papilio polytes, Papilio polymnestor Papilio clytia, Papilio demoleus* under the genus *Papilio.* Eight genera, namely *Ariadne* (*Ariadne merione, Ariadne ariadne*), *Catopsilia* (*Catopsilia pomona, Catopsilia pyranthe*), *Danaus* (*Danaus chrysippus, Danaus genutia*), *Eurema* (*Eurema hecabe, Eurema brigitta*), *Graphium* (*Graphium agamenon, Graphium doson*), *Jamides* (*Jamides bochus, Jamides celeno*), *Lethe* (*Lethe europa, Lethe rohria*), *Ypthima* (*Ypthima huebneri, Ypthima baldus*) were noticed with 2 species each. The remaining 41 genera were comprised of one species each. The value of species genus ratio was 1.33.

Table 2 illustrates the species diversity and evenness of the butterfly community of the study site which were expressed by the diversity indices such as Shannon diversity index (H'), Pielou's evenness index (j), Simpson's diversity index (Ds) and Simpson's index of diversity (D). The Shannon diversity index (H') value (3.79) portrayed that the species richness and diversity of the butterfly fauna at the study site was very high. The abundance of the butterfly community was estimated by the Simpson's diversity index (Ds) whose value was more inclined towards 0 indicating the prevalence of high species abundance within the butterfly community. Again, the value of Simpson's index of diversity (D=0.97) indicated that the observed butterfly community with high abundance. The value of Pielou's evenness index (j=0.90) was inclined towards 0 which depicted that more evenness among the butterfly species existed in the studied butterfly community. All these values expressed the butterfly community was highly diverse with high abundance and high evenness, thus signifying the community was in the direction of an ideal natural community.

Table 3 represented the family-wise values of various biodiversity indices, such as Shannon diversity index (H'), Shannon H_{max}, Pielou's evenness index (j), Simpson's diversity index (Ds), Simpson's index of diversity index (D) and Simpson's reciprocal index (Dr). The Shannon diversity index (H') value of the recorded six butterfly families ranged from 0.00 to 3.10. In this case, the family Nymphalidae was noted with the highest value as the maximum number of species were recorded from this family, followed by Lycaenidae, Hesperiidae, Pieridae, Papilionidae whereas, the least value was observed from the Riodinidae family as only one species was found under this family. Additionally, the values of Shannon H_{max} showed that family Nymphalidae (3.00) was the most diverse, followed by Pieridae (2.53) Lycaenidae (2.51) and Papilionidae (2.05). The values of Pielou's evenness index (j) determine whether a community is evenly distributed or not. This value was highest in case of Hesperiidae (0.91), followed by both Nymphalidae (0.89) and Papilionidae (0.89), Pieridae (0.82), Lycaenidae (0.81). In the current study, the value of Simpson's reciprocal index (Dr) indicated that higher diversity of butterfly was observed in the family Nymphalidae (17.35).

Figure 3(i) demonstrated the Whittaker plot i.e., species-wise rank abundance curve that explains the species abundance with evenness and family-wise rank abundance curve (figure 3ii) that illustrated the species abundance and evenness among the six families. The Whittaker plot's curve of the butterfly fauna showed a steep inclination up to the first six butterfly species that stated in the surveyed community, 6 butterfly species occurred in high abundance with less evenness in comparison to the remaining species. Species rank tenth onwards the abundances of the observed butterfly species were reduced accordingly with increased evenness among the recorded species in the butterfly community.

While considering the family-wise rank abundance curve, it was clearly observed that more evenness was in family Hesperiidae, followed by family Nymphalidae and Papilionidae, whereas, family Lycaenidae showed relatively less evenness.

Table 1: Checklist of butterfly species along with their family, relative abundance, status and WPA Schedule recoded in the study area.

Sl. No.	Family	Common Name	Scientific name	Relative Abundance	Status	WPAschedule
1	Nymphalidae	Common Crow	*Euploea core*	1.51	NR	
2		Common Evening Brown	*Melanitis leda*	6.22	VC	
3		Dark Brand Bushbrown	*Mycalesis mineus*	0.81	R	
4		Long Brand Bushbrown	*Mycalesis visala*	0.97	NR	
5		Common Bushbrown	*Mycalesis perseus*	5.68	VC	
6		White-bar Bushbrown	*Mycalesis anaxias*	0.65	R	Schedule II
7		Bamboo Treebrown	*Lethe europa*	0.32	R	
8		Common Treebrown	*Lethe rohria*	0.97	NR	
9		Grey Pansy	*Junonia atlites*	2.43	NR	
10		Lemon Pansy	*Junonia lemonias*	3.14	C	
11		Peacock Pansy	*Junonia almana*	0.81	R	
12		Chocolate Pansy	*Junonia iphita*	2.97	C	
13		Common Leopard	*Phalanta phalantha*	2.00	NR	
14		Common Palmfly	*Elymnias hypermnestra*	1.24	NR	
15		Common Eggfly	*Hypolimnas bolina*	1.30	NR	
16		Common Baron	*Euthalia aconthea*	0.49	R	
17		Baronet	*Symphaedra nais*	2.22	NR	
18		Plain Tiger	*Danaus chrysippus*	1.57	NR	
19		Striped Tiger	*Danaus genutia*	0.65	R	Schedule II
20		Blue Tiger	*Tirumala limniace*	0.16	R	
21		Common Castor	*Ariadne merione*	1.30	NR	
22		Angled Castor	*Ariadne ariadne*	1.51	NR	
23		Common Map	*Cyrestis thyodamas*	0.27	R	
24		Common Sergeant	*Athyma perius*	1.03	NR	
25		Common Lascar	*Pantoporia hordonia*	0.05	VR	
26		Common Sailer	*Neptis hylas*	3.14	C	
27		Commander	*Moduza procris*	0.59	R	
28		Common Earl	*Tanaecia julii*	0.70	R	Schedule II
29		Tawny Coster	*Acraea terpsicore*	2.33	NR	
30		Tawny Rajah	*Charaxes bernardus*	0.05	VR	Schedule II
31		Common Fourring	*Ypthima huebneri*	5.46	VC	
32		Common Fivering	*Ypthima baldus*	2.11	NR	
33	Papilionidae	Common Mormon	*Papilio polytes*	1.57	NR	
34		Blue Mormon	*Papilio polymnestor*	0.11	VR	
35		Common Mime	*Papilio clytia*	0.65	R	Schedule I
36		Lime Butterfly	*Papilio demoleus*	1.68	NR	
37		Tailed Jay	*Graphium agamemnon*	1.30	NR	
38		Common Jay	*Graphium doson*	0.70	R	
39	Pieridae	Common Wanderer	*Pareronia valeria*	0.38	R	
40		Common Grass Yellow	*Eurema hecabe*	2.76	C	
41		Small Grass Yellow	*Eurema brigitta*	0.49	R	
42		Psyche	*Leptosia nina*	0.70	R	
43		Common Emigrant	*Catopsilia Pomona*	5.62	VC	
44		Mottled Emigrant	*Catopsilia pyranthe*	4.38	C	
45		Striped Albatross	*Appias libythea*	0.22	R	Schedule IV
46		Common Gull	*Cepora nerissa*	1.84	NR	Schedule II
47		Common Jezebel	*Delias eucharis*	0.97	NR	
48		Large Cabbage White	*Pieris brassicae*	0.87	NR	
49	Lycaenidae	Common Pierrot	*Castalius rosimon*	2.43	NR	Schedule I
50		Angled Pierrot	*Caleta decidia*	1.03	NR	Schedule II
51		Striped Pierrot	*Tarucus nara*	1.35	NR	Schedule II
52		Grass Jewel	*Freyeria trochylus*	0.43	R	
53		Quaker	*Neopithecops zalmora*	6.65	VC	
54		Plains Cupid	*Luthrodes pandava*	0.81	R	
55		Dark Cerulean	*Jamides bochus*	0.87	NR	
56		Common Cerulean	*Jamides celeno*	2.11	NR	
57		Pea Blue	*Lampides boeticus*	0.38	R	Schedule II
58		Zebra Blue	*Leptotes plinius*	0.11	VR	
59		Common Hedge Blue	*Acytolepis puspa*	0.59	R	
60		Lime Blue	*Chilades lajus*	0.70	R	
61	Riodinidae	Plum Judy	*Abisara echerius*	0.32	R	Schedule II
62	Hesperiidae	Grass Demon	*Udaspes folus*	0.11	VR	
63		Pied Flat	*Coladenia indrani*	0.16	R	
64		Snow Flat	*Tagiades japetus*	0.27	R	Schedule II
65		Small Branded Swift	*Pelopidas mathias*	0.59	R	
66		Palm Bob	*Suastus gremius*	0.27	R	
67		Common Small Flat	*Sarangesa dasahara*	0.43	R	
68		Indian Skipper	*Spialia galba*	0.97	NR	
69		Dark Palm Dart	*Telicota bambusae*	0.49	R	

VC - very common (>100 sightings), C – common (51 to 100 sightings), NR – nor rare (16 to 50 sightings), R – rare (3 to 15 sightings), VR – very rare (1 to 2) to indicate the rarest to the most common butterfly species (Tiple *et al.*, 2006)
WPA- Species enlisted in Indian Wildlife Protection Act, 1972.

Table 2: Values of different biodiversity indices of butterfly population of the study area

Shannon diversity index (H')	Pielou's evenness index (j)	Simpson's diversity index (Ds)	Simpson's index of diversity (D)
3.79	0.90	0.03	0.97

Table 3: Values of different biodiversity indices of six butterfly families of the study area.

Family	Shannon diversity index (H')	Shannon H_{max}	Pielou's evenness index (j)	Simpson's diversity index (Ds)	Simpson's index of diversity (D)	Simpson's reciprocal index (Dr)
Nymphalidae	3.10	3.00	0.89	0.06	0.94	17.35
Papilionidae	1.60	2.05	0.89	0.21	0.79	4.57
Pieridae	1.88	2.53	0.82	0.19	0.81	5.16
Lycaenidae	2.00	2.51	0.81	0.19	0.81	5.08
Riodinidae	0.00	0.78	0.00	1.00	0.00	1.00
Hesperiidae	1.89	1.79	0.91	0.16	0.84	5.70

Fig 1: Map of Odisha (i), vegetation of Barbara Forest (ii) and satellite image of study area (iii).

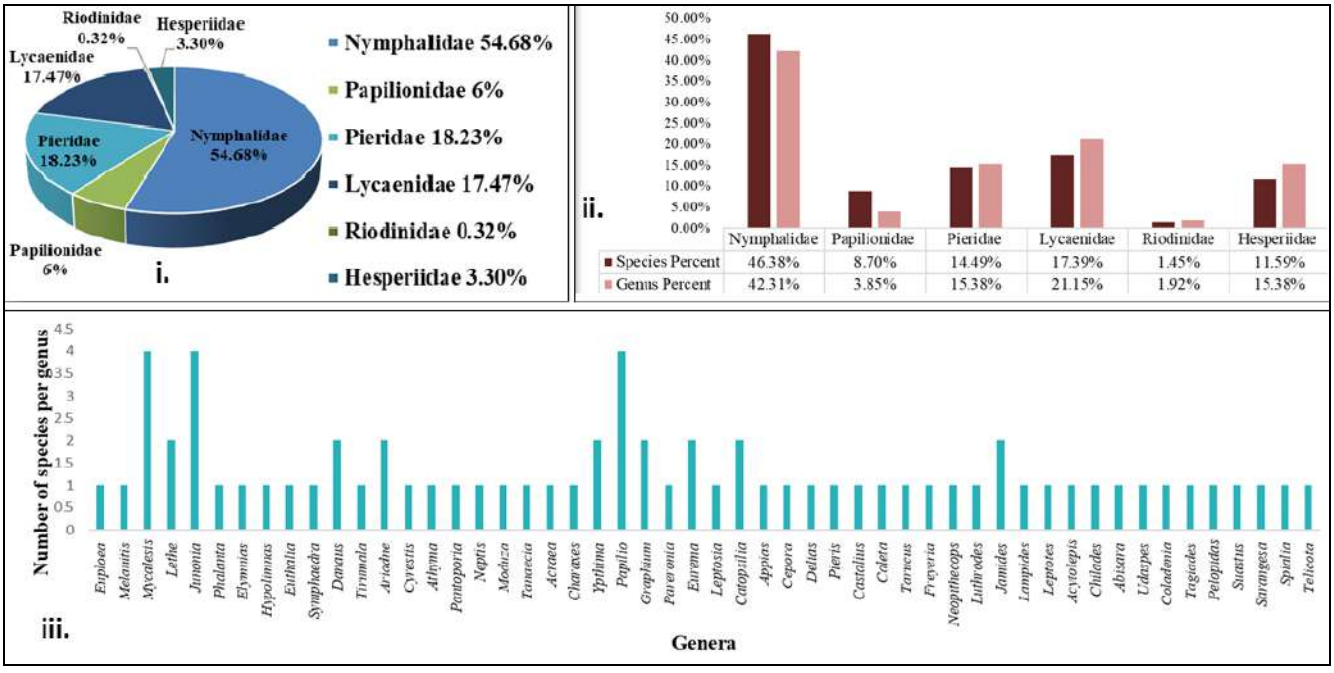

Fig 2: Percentage composition (i), genus to species proportion of butterflies of six families (ii), and genus wise species richness of the recorded butterfly genera (iii) of the study site.

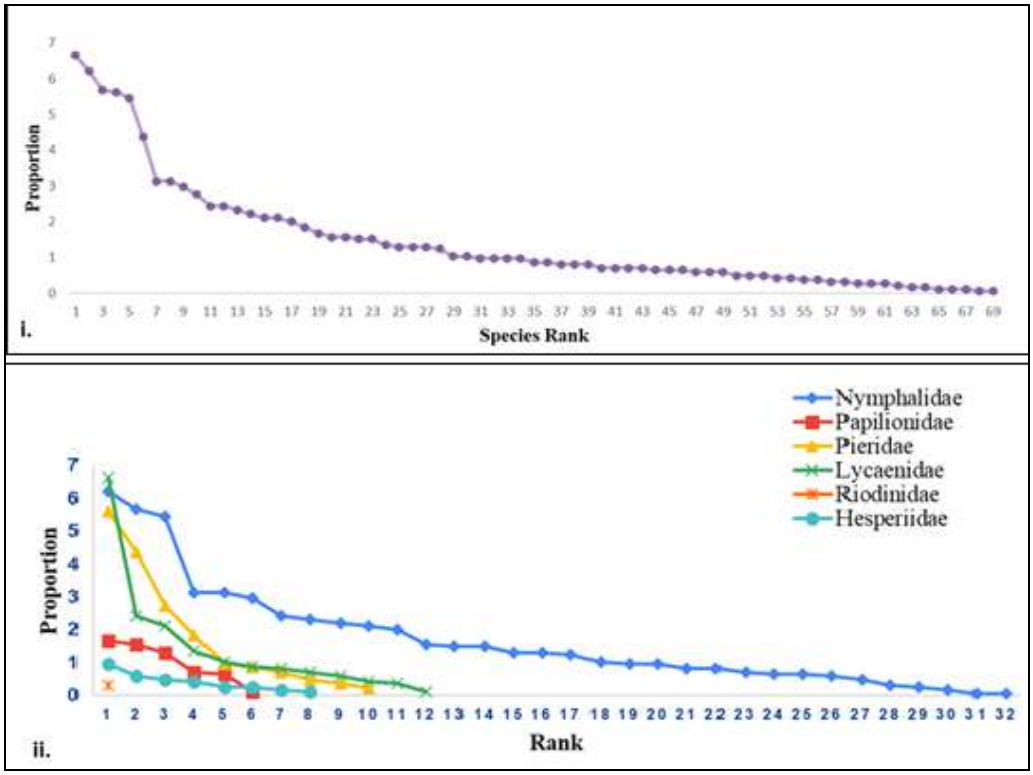

Fig 3: Rank abundance curve of 69 species of butterfly (i) and rank abundance curve of six families of butterfly community (ii) in the study area.

Fig 4: Photographs of different butterfly species recorded in the study area, 1) *Luthrodes pandava*, 2) *Tirumala limniace*, 3) *Neptis hylas*, 4) *Hypolimnas bolina*, 5) *Junonia almana*, 6) *Elymnias hypermnestra*, 7) *Euthalia aconthea*, 8) *Danaus chrysippus*, 9) *Cepora Nerissa*, 10) *Graphium doson*, 11) *Junonia lemonias*, 12) *Danaus genutia.*

Fig 5: Photographs of different butterfly species recorded in the study area, 13) *Catopsilia pyranthe*, 14) *Junonia atlites*, 15) *Papilio demoleus*, 16) *Ypthima huebneri*, 17) *Papilio polytes*, 18) *Lampides boeticus*, 19) *Freyeria trochilus*, 20) *Tagiades japetus*, 21) *Acraea terpsicore*, 22) *Castalius rosimon*, 23) *Leptotes plinius* 24) *Caleta decidia.*

Discussion

Butterflies serve as important components of forest ecosystem by facilitating various ecosystem services like pollination, acting as a biopesticide and maintaining food web equilibrium and steadiness as herbivores (Mahata and Palita, 2022) [17]. Butterflies are also correlated with abundance and distribution of plants in a particular area (Kitahara *et al*., 2008; Van Halder *et al*., 2008) [12] [37]. The Barbara Forest located near Chilika Lake in coastal Odisha, which spans over three districts namely Khordha, Nayagarh and Ganjam is considered as Asia's largest teak and sal forest. The tropical deciduous forests serve as a hotspot of biodiversity, thus harboring diverse flora and fauna. The dense forest, along with its open grassland provide a suitable habitat for the assemblage of diverse as well as endemic butterfly fauna.

A total number of 69 butterflies, belonging to six different families were recorded from the study site. Maximum number of butterflies documented from the study site belonged to family Nymphalidae, followed by Pieridae and Lycaenidae which is similar to the findings of Palei and Rath (2014) [24], documented at Sunabeda Wildlife Sanctuary, Odisha. Few rare butterfly species such as Common Lascar (*Pantoporiahordonia*), Tawny Rajah (*Charaxespolyxena*), Blue Mormon (*Papilio polymnestor*), Zebra Blue (*Leptotesplinius*), Grass Demon (*Udaspesfolus*) recorded from the survey site are in accordance to the findings of Boruah *et al*. (2018) [5],recorded from Manchabandha and Budhikhamari Reserve Forest situated in Mayurbhanj, Odisha. Only one butterfly species i.e. Plum Judy (*Abisaraecherius*) was recorded from Riodinidae family, which was also similar to the records of Acharya and Pal (2018) [1] from a study conducted around Chandandhara waterfall, situated in Nabarangpur, Odisha. Butterflies belonging to family Papilionidae are especially sensitive to pollution, therefore found mostly in less polluted areas (Boruah and Bora, 2022) [4]. As the number of recorded butterflies of familyPapilionidae was found relatively less that depicted pollution is slowly engulfing the forest area. Members of the Pieridae family namely Common Emigrant (*Catopsiliapomona*) and Common Grass Yellow (*Euremahecabe*) were seen mud puddling in soil

pits created along the forest path. Under Lycaenidae family the most abundant butterfly species was Quaker (*Neopithecops zalmora*), found in groups along the sides of forest track. Only eight butterflies were recorded from Hesperiidae family, which is quite low in comparison to the previous works conducted by Boruah *et al*. (2018) [5] and Payra *et al*. (2019) [26] at Manchabandha and Budhikhamari Reserve Forest and Athgarh Forest Division, Odisha respectively. Boruah *et al*. (2018) [5] recorded the presence of twenty-one butterfly species belonging to family Hesperiidae, while Payra *et al*. (2019) [26] recorded twenty-seven butterfly species. The possible reason of such a smaller number of Hesperiidae butterflies in the study site might be due to variation in habitat type or anthropogenic disturbances. Habitat degradation due to anthropogenic impact frequently cause habitat shift or local extinction of butterfly species.

The forest tracts provide an exclusive habitat to harbor diverse flora and fauna. The biogeographic features, as well as the climate of the study site is quite favorable for the assemblage of butterfly community. However, ecotourism efforts have led to human intervention and destructive activities causing loss of flora and fauna in the recent years. The thick forests of Barbara are inhabited by megafauna such as elephants, giant squirrels, sambar deer, bison etc., as well as microfauna like butterflies, therefore conservation initiatives are of utmost importance. The present survey-based study provided a checklist of the recorded butterflies and estimated all the diversity indices. This will be helpful in implementing necessary conservation strategies in Barbara Forest, thus safeguarding the forest habitats as well as the diverse butterfly fauna of this region.

Conclusion

The present study depicted the presence of a diverse butterfly community in the Barbara Forest. The tropical deciduous forest provides a favorable environment for the assemblage of these brightly coloured winged hexapods. The forest is endowed with diverse flora and fauna. But increased ecotourism has led to a negative impact on the forest habitat. Therefore, there is a need of adopting necessary conservation strategies to conserve the biodiversity residing in the forest. The data recorded in the survey will prove to be beneficial by providing reference for future studies.

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