International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 09-02-2025, Accepted: 10-03-2025, Published: 26-03-2025
Volume 10, Issue 3, 2025, Page No. 176-185

Studies on butterfly (Insect: lepidoptera) diversity in Narayani temple sacred grove in a patch of forest of Ganjam, Odisha, India

Dr. Mousumi Das[1*], Avishikta Ghosh[2], Somdutta Basu Thakur[2]
[1] Assistant Professor, Department of Zoology, Vidyasagar College, Kolkata, India
[2] Department of Zoology, Vidyasagar College, Kolkata, India

Abstract
The present survey was conducted to assess the diversity and abundance of butterfly fauna in Narayani Temple sacred grove situated in Ganjam district of Odisha, India for seven consecutive days in the month of December, 2024. The dense tropical deciduous forests serve as a hotspot of biodiversity, sustaining diverse butterfly fauna. The study recorded the presence of 98 different butterfly species, belonging to six families and 66 different genera. Highest number of butterfly species were recorded from family Nymphalidae (34.73%) followed by Pieridae (31.22%), Lycaenidae (21.25%), Papilionidae (6.52%), Hesperiidae (5.71%) and the least number of butterfly species were observed from the family Riodinidae (0.57%). On the basis of sightings of butterfly species, 55.42% of the butterfly species were under not rare category, 23.76% were under rare category, 12.73% were under very common category, 6.96% were under common category and lastly 1.13% under very rare category. Among the recorded butterfly species, 21 of them are legally protected under various schedules of Wildlife Protection Act, 1972. Values of studied diversity indices such as Shannon diversity index (H'= 4.17), demonstrated the high species richness of the butterfly community. Pielou's evenness index (j=0.91) depicted the evenly distributed nature of the recorded butterfly species. Simpson's index of diversity (D= 0.02) 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 habitat as well as the butterfly fauna in Narayani Temple sacred grove.

Keywords: Butterfly community, diversity indices, Nymphalidae, sacred grove, species richness

Introduction

Butterflies are enchanting, brightly coloured scaly winged insects of order Lepidoptera are distributed worldwide. It is one of the best taxonomically studied groups of insects (Robbins and Opler, 1997) [34] due to of their different ecosystem services such as in food web stability as herbivores (Pearse and Altermatt, 2013) [31], pollination (Webb, 2008) [48], biological pest control and induce genetic variation in plants (Ghazanfar *et al*., 2016) [7] and flagship species for conservation (Thomas, 2005) [44]. Butterflies are considered as the potential taxa for biodiversity assessment which was confirmed by several educational and environmental investigations (Hayes *et al*., 2009) [8]. Most of the butterflies are habitat specific where they complete their life cycle (Nowicki *et al*., 2008) [25]. They are highly sensitive to change in climatic factors like temperature, humidity, and light levels and are promptly affected by any disturbances or variation in habitat health (Tiple *et al*., 2011) [46]. In recent times, study on butterfly diversity and abundance have been conducted frequently to assess health of ecosystem because they are one of the main bioindicator (MacDonald *et al*., 2017) [16].

More than 17000 butterfly species are identified in world (Kumar, 2014) [13] and around 1504 species have been documented from Indian subcontinent (Kunte *et al*., 2012) [14] which constituted 8.74% of the total butterfly species present worldwide. Out of the which, 285 species were documented from Southern India, 351 and 334 species from Peninsular India and Western Ghats respectively (Palei and Rath, 2014) [27] and about 200 butterfly species from Odisha (Mohapatra *et al*., 2012) [38]. Odisha, the junction of four biotic provinces (Rodgers and Panwar, 1988) [35], is the transitional zone for biota of Southern India and Northeast India (Saxena and Brahmam, 1989) [36] which was asserted by the reports on herpetofauna by Dutta *et al*. (2009) [6], birds and butterflies by Nair (2011) [24]. The Eastern Ghats, a discontinuous range of mountains containing a treasury of biodiversity, sharing about 25% of it in Odisha, spreading over in 19 districts, namely Mayurbhanj, Keonjhar, Balasore, Jaipur, Angul, Dhenkanal, Cuttack, Khurda, Nayagarh, Phulbani, Boudh, Kalahandi, Gajapati, Ganjam, Rayagada, Nawrangpur, Koraput, Malkanagiri and Kandhamal (Rao *et al*., 2021) [33]. Though, conservation approaches and historical wildlife documentationwere less well known for Eastern Ghats, from last 50 year's rapid explorations of wildlife recognize it as a reservoir for biodiversity and endemism. Ganjam a district of Odisha, endowed with mountains, coastline and forests, offers a diverse range of flora and fauna. Mahendragiri Range of eastern ghat cover the entire district. The region is mostly dominated by tropical deciduous forest with close canopy cover and meadows which made it a sanctum for the highly diverse and endemic butterfly fauna (Sutton and Collins, 1991) [43]. Kunte *et al*. (2020) [15] reported Himalayas and Western Ghats regions harbour a very good number of endemic butterfly species. Butterfly fauna of Odisha is poorly recorded in comparison to other biogeographic zones of India. In recent past, systematic surveys and documentations of butterfly fauna of Odisha were conducted, but almost entirely in the protected area networks (Palei and Rath, 2014; Paria *et al*., 2018) [27] [28]. Mohapatra *et al*. (2012) [23] reported170 butterfly species from Bonai Forest Division, Sethy and Jena (2009) [37] documented 50 species from Gudgudia range of Similipal Tiger reserve, Mishra *et al*. (2010) [20] reported 93 species from Nandankanan Wildlife Sanctuary and Palei and Rath

(2014) [27] reported 101 species from Sunabeda Wildlife Sanctuary. In this regard, Payra *et al*. (2016) [29] and Nair (2011) [24] stated the presence of high butterfly diversity from Similipal Biosphere Reserve. But, a very few studies have been carried out in other major forest areas with biodiversity rich habitats.

The forest patches, generally around a temple, stupas (Katuwal *et al*., 2016) [11] or old tree, are protected and conserved by the local people traditionally for cultural and spiritual significance, religious belief, burial grounds, and watershed value (Shrestha *et al*., 2015; Yadav *et al*., 2010) [40] [50] are referred as sacred groves. These sites, harbouring rich biodiversity and provide ecosystem services, are under the in-situ biodiversity conservation (Shrestha and Devkota, 2013) [39]. There are around 13,720 sacred groves have been documented from India (Malhotra *et al*., 2001) [18]. Odisha is estimated to harbour about 2166 sacred groves (Ormsby and Rath, 2020) [26]. One such is Maa Narayani temple, a hillside temple, situated at the edge of forest in Ganjam district. Documentation and detailed study on butterfly fauna from the sacred forest of Odisha had never been conducted yet.

The present study was undertaken to explore the butterfly diversity and abundance of Maa Narayani temple sacred grove, Ganjam district, Odisha, India. The present study will provide an insight of butterfly fauna inhabiting in the sacred grove as well as the important of sacred groves on butterfly conservation.

Materials and Methods

Study Area

The present study was conducted in a sacred grove, Maa Narayani temple located at the edge of forest area in Ganjam district, Odisha. The study area covered a distance of about 4 km from the crossing of Narayani Road and Jaipur Road (19.67877°N, 85.17203°E) to Maa Narayani temple (19.69739°N, 85.15328°E). The Ganjam district and its adjoining areas typically experience a tropical climate with average annual maximum temperature of 37°C and minimum temperature of 20°C. The annual rainfall experienced this area is about 1444mm, with the monsoon season spanning from June to September.

Survey Technique

Data collection was based on a survey tour of seven days during the month of December, 2024 when the climate was good and pleasant with neither heavy rain nor heavy wind. Simple observation methods were used, either by 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 Narayani Road with 5 m on either side for five hours maintaining a constant pace between 09:00 h to 13:00 h. To cover the entire survey path of about 4 km, a total number of eight 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) [32]. All the butterfly species observed during the sampling period were recorded along with their number.

Majority of the butterfly species were identified by direct observation in the field or in few difficult cases snapped photographs were used for identification by following the keys of Kehimkar (2016) [12], and Dey *et al*. (2017) [5]. 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) [47].

Statistical data Analysis

To understand the community structure of the butterfly species in the sampled site, all the recorded data were usedto 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) [38], Simpson index (Simpson, 1964) [41] and Pielou's index (Mulder *et al*., 2004) [22] respectively. To explain species richness and evenness a rank abundance curve was prepared (Whittaker, 1965) [49].

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

Shannon H_{max}= Log_1 (N)

Dominance index (D_{BP})= ni/N (Berger and Parker, 1970) [2]

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

Results

The satellite image of the present study site is presented in figure 1. The table 1 demonstrates the checklist of the recorded butterfly species spotted during the survey period accompanied by their family, relative abundance and WPA schedule (Wildlife Protection Act, 1972). The survey recorded the presence of 98 different butterfly species belonging to six families and 66 different genera. The most abundant butterfly species found in the study site was the Common Emigrant (*Catopsilia Pomona*; RA-6.39) followed by Common Grass Yellow (*Eurema hecabe*; RA-6.33), Common *Evening* Brown (*Melanitis leda*; RA-3.64), Mottled Emigrant (*Catopsilia pyranthe*; RA-3.32), Small Grass Yellow (*Eurema brigitta*; RA-2.76), Quaker (*Neopithecops zalmora*; RA-2.57), Psyche (*Leptosia nina*; RA-3.38), Common gull (*Cepora Nerissa*; RA-3.32), Tricolour Pied Flat (*Coladenia Indrani*; RA-3.19), Common Fourring (*Ypthima huebneri*; RA-2.01) and Three Spot Grass Yellow (*Eurema blanda*; RA-2.01). A total number of 28 butterfly species were found with relative abundance from 2.00 to 1.00, namely *Castalius rosimon*, *Hypolimnas bolina*, *Euploea core*, *Ypthima baldus*, *Parantica aglea*, *Zizula hylax*, *Polyura athamas*, *Acraea terpiscore*, *Tarucus nara*, *Pantoporia hordonia*, *Papilio polytes*, *Neptis hylas*, *Danaus chrysippus*, *Eurema andersonii*, *Junonia iphita*, *Eurema laeta*, *Appias libythea*, *Junonia atlites*, *Jamides celeno, Zizeeria karsandra*, *Ariadne merione*, *Junonia almanac*, *Elymnias hypermnestra*, *Graphium Agamemnon*, *Junonia lemonias*, *Symphaedra nais, Pseudozizeeria maha* and *Amblypodia anita.* While, the relative abundance of the remaining butterfly species of the study site were less than1. The species counted with only one in number were considered as the rarest species of the study area, namely Painted Lady (*Vanessa cardui*), Black Rajah (*Charaxes solon*) and Orange Oakleaf (*Kallima inachus*) of Nymphalidae family, Common Birdwing (*Troides helena*) of Papilionidae family, Common Small Flat (*Sarangesa*

dasahara) and Common Redeye (*Matapa aria*) of Hesperiidae family.

Under Nymphalidae family, Common Evening Brown (*Melanitis leda*) was the most abundant butterfly species, followed by Common Fourring (*Ypthima huebneri*), Great Eggfly (*Hypolimnas bolina*). When the Lycaenidae family was taken into consideration, Quaker (*Neopithecops zalmora*) was found to be the most abundant species followed by Common Pierrot (*Castalius rosimon*) while the least abundant species were Dark Cerulean (*Jamides bochus*) and Zebra Blue (*Leptotes plinius*). While considering the family Pieridae, Common Emigrant (*Catopsilia pomona*) was found to be the most abundant species followed by Common Grass Yellow (*Eurema hecabe*) whereas Dark Clouded Grass Yellow (*Colias fieldii*) was found to be the rarest one. In family Papilionidae, Common Mormon (*Papilio polytes*) was the most counted species followed by Tailed Jay (*Graphium agamemnon*). Lastly, under family Hesperiidae Tricolour Pied Flat (*Coladenia indrani*) was recorded with maximum number, followed by Common Snow Flat (*Tagiades japetus*) and Indian Skipper (*Spialia galba*) with similar abundance.

Analysis of the percentage composition of the six butterfly families at the study site (figure 2) illustrated that family Nymphalidae had the maximum number of butterflies with 34.73% of total population followed by Pieridae (31.22%), Lycaenidae (21.25%), Papilionidae (6.52%), Hesperiidae (5.71%) and the least number of butterflies were counted from the family Riodinidae (0.57%).

Genus wise species richness analysis portrayed that maximum number of genera was enumerated from family Nymphalidae with 24 genera (36.36%), followed by Lycaenidae with 20 genera (30.30%), Hesperiidae with 10 genera (15.15%), Pieridae with 7 genera (10.61%), Papilionidae with 4 genera (6.06%) and lastly Riodinidae with only one genus (1.52%). When species-wise diversity was taken into consideration, it was found that family Nymphalidae (36.73%) had the maximum number of species, followed by Lycaenidae (24.49%), Papilionidae (14.29%), Pieridae (12.24%), Hesperiidae (11.22%) and lastly Riodinidae (1.02%) (figure 2).

On the basis of the prevalence of the recorded butterflies from the survey site, they were categorized into five classes namely very common (VC), common (C), not rare (NR), rare (R) and very rare (VR). The study showed that 55.42% of the butterfly population were under NR category, 23.76% under R category, 12.73% under VC category, 6.96% under C category and lastly 1.13% under VR category.

Most of the sampled butterfly species were ‘common’ and ‘generalist species’ and none of them were universally threatened according to the IUCN Red List (Ver 3.1), however only twenty-one butterfly species were noted to be protected under Wildlife Protection Act, 1972. Among these butterfly species, three of them were protected under Schedule I namely Common Pierrot (*Castalius rosimon*), Common Mime (*Papilio clytia*) and Crimson Rose (*Pachliopta hector*), sixteen of them are protected under Schedule II namely Common Nawab (*Polyura athamas*), Blue Spotted Crow (*Euploea midamus*), Striped Tiger (*Danaus genutia*), Common Baron (*Euthalia aconthea*), Tawny Rajah (*Charaxes bernardus*), Black Rajah (*Charaxes solon*), Marbled Map (*Cyrestis cocles*), Striped Pierrot (*Tarucus nara*), Angled Pierrrot (*Caleta decidia*), Pea Blue (*Lampides boeticus*), Gram Blue (*Euchrysops cnejus*), Leaf Blue (*Amblypodia anita*), Common Gull (*Cepora nerissa*), One Spot Grass Yellow (*Eurema andersonii*), Common Snow Flat (*Tagiades japetus*), Tricolour Pied Flat (*Coladenia indrani*) and Striped Albatross (*Appias libythea*) and Common Indian Crow(*Euploea core*) are protected under Schedule IV.

From the survey site it was observed that, maximum number of species were from genus *Papilio*, which comprised of seven species (*Papilio polytes, Papilio polymnestor, Papilio demoleus, Papilio nephelus, Papilio clytia, Papilio paris, Papilio crino*) followed by *Junonia* with six species (*Junonia lemonias, Junonia almana, Junonia iphita, Junonia atlites, Junonia hierta, Junonia orithya*), *Eurema* with five species (*Eurema laeta, Eurema andersonii, Eurema blanda, Eurema brigitta, Eurema hecabe*) and *Graphium* with four species (*Graphium agamemnon, Graphium doson, Graphium nomius, Graphium sarpedon*). The remaining 62 genera were recorded to possess only two or one species each (figure 2). Species Genus ratio was 1.48.

Table 2 represents the species diversity and evenness of the butterfly community of the study site which were expressed by the 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 (4.17) illustrated that the species richness and diversity of the butterfly fauna in 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 indicated the prevalence of high species abundance within the community. Again, the value of Simpson's index of diversity (D=0.98) indicated that the observed butterfly community was a diverse one. The value of Pielou’s evenness index (j=0.91) value 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, and 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 3.26. In this case, the family Nymphalidae showed the highest value as the maximum number of species were recorded from this family, followed by Lycaenidae, Papilionidae, Pieridae, Hesperiidae whereas, the least value was observed from the Riodinidae family as only one species was recorded under this family. Additionally, the values of Shannon H_{max} showed that family Nymphalidae (2.74) was the most diverse, followed by Pieridae (2.7) and Lycaenidae (2.53) and Papilionidae (2.02). The values of Pielou’s evenness index (j) determine whether a community is evenly distributed or not. This value was highest in Lycaenidae (0.94), followed by both Nymphalidae (0.91) and Pieridae (0.91), Papilionidae (0.87), Hesperiidae (0.81). In the current study, the value of Simpson's reciprocal index (Dr) indicated that higher diversity of butterfly was seen in the family Nymphalidae (22.14), followed by Lycaenidae (17.11), Pieridae (8.02),

Papilionidae (7.89), Hesperiidae (4.96) and least value was observed in the Riodinidae (1.00) family.

Figure 3 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 3) that depicted the species abundance and evenness among the six families. The Whittaker plot's curve of the butterfly fauna showed a steep inclination which depicted that two butterfly species in the surveyed community occurred in high abundance in comparison to the remaining species. The plot revealed that the first nine species were more in abundance with less evenness as there was a steep gradient in the curve. 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 Nymphalidae, followed by family Lycaenidae, Papilionidae, Hesperiidae whereas, family Pieridae with relatively less evenness.

Discussion

Butterflies are remarkable component of biodiversity found in nature, familiar for their circuitous and sturdy interconnections inside the food web (Bonebrake *et al*., 2010) [4]. They act as an efficient ecological indicator by reacting to any disturbances or any minor difference in habitat (Mac Nally and Fleishman, 2004) [17]. They act as pollinators, herbivores and prey to variety of predators, thus enabling structural and functional maintenance of the ecosystem (Bonebrake *et al*., 2010) [4]. Hence, systematic surveys regarding butterfly diversity and abundance are of utmost importance in order to assess their distribution in a particular region.

Maa Narayani temple which is situated in the forest area of Ganjam district, Odisha serves as a sacred grove, conserving the floral and faunal diversity in that area. A good assemblage of butterfly species was recorded from the study site comprising of 98 different species belonging to six different families.

The present study recorded the highest number of butterfly species from family Nymphalidae perhaps due to their morphological attributes, polyphagous nature and great flying capacity (Majumder *et al*., 2012) [19]. After family Nymphalidae, Pieridae was recorded with maximum number of butterfly species which was in accordance with the studies conducted by Palei and Rath (2014) [27], at the Sunabeda Wildlife Sanctuary, Odisha as well as by Mohanta and Behera (2018) [21] in the coastal region of Ganjam. The region is comprised of large trees which extend to form a canopy, along with shrubs, agricultural fields and a water body which is perfectly suitable for the assemblage of a large number of butterfly species. Few species like *Catopsilia pomona, Eurema hecabe*were seen mud puddling in the wet soil depressions near the water body. Very few butterfly species were recorded from the Hesperiidae family probably due to their shade loving nature and their specificity to selected host plants. A similar finding was reported by Singh *et al*. (2019) [42] conducted in agronomy field, Bhubaneswar, Odisha. Only one butterfly species was recorded from family Riodinidae which was similar to the prior study of Acharya and Pal (2019) [1] in Athgarh Forest division, Odisha. In the present study, a total number of 13 butterflies were recorded from family Papilionidae, which is similar to the findings of Palei and Rath (2014) [27] as they also recorded the presence of 14 butterfly species under the Papilionidae family from Sunabeda Wildlife Sanctuary, Odisha, whereas Payra *et al*. (2019) [30] recorded the presence of 11 butterfly species belonging to Papilionidae family from the Athgarh Forest Division, Odisha.

Butterflies are considered as umbrella species by ecologists for the purpose of conservation planning as well as management (Betrus *et al*., 2005) [3]. Therefore, butterfly diversity reports act as an effective tool for the floral as well as faunal biodiversity studies, assessment of pollution level and habitat health, and lastly for adopting conservation management strategies (Hortal *et al*., 2015) [9]. The present study area comprised of large trees and a natural landscape unharmed by anthropogenic activities, thus promoting assemblage of a huge number of butterfly fauna. The butterflies that were recorded from the study site comprised of common as well as rare and scheduled species, which portrays the highly diverse nature of the butterfly community. In addition to the high abundance with species richness, butterflies were evenly distributed among the six different families as well as throughout the study area. Moreover, the forest patch harbours splendid flora and fauna which indicate the immense potential of the study area, thus aiming to conserve biodiversity.

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

Sl. No.	Family	Common Name	Scientific name	Relative Abundance (RA)	Status	WPA schedule
1	Nymphalidae	Common Nawab	*Polyura athamas*	1.63	NR	Schedule II
2		Angled Castor	*Ariadne ariadne*	0.25	R	
3		Common Castor	*Ariadne merione*	1.13	NR	
4		Lemon Pansy	*Junonia lemonias*	1.07	NR	
5		Peacock Pansy	*Junonia almana*	1.13	NR	
6		Chocolate Pansy	*Junonia iphita*	1.38	NR	
7		Grey Pansy	*Junonia atlites*	1.19	NR	
8		Yellow Pansy	*Junonia hierta*	0.69	R	
9		Blue Pansy	*Junonia orithya*	0.25	R	
10		Common Evening Brown	*Melanitis leda*	3.64	C	
11		Blue Spotted Crow	*Euploea midamus*	0.25	R	SCHEDULE II
12		Common Indian Crow	*Euploea core*	1.69	NR	SCHEDULE IV
13		Common Leopard	*Phalanta phalantha*	0.44	R	
14		Plain Tiger	*Danaus chrysippus*	1.50	NR	
15		Striped Tiger	*Danaus genutia*	0.63	R	SCHEDULE II
16		Common Bushbrown	*Mycalesis perseus*	0.94	R	
17		Dark brand Bushbrown	*Mycalesis mineus*	0.13	VR	

18		Common Palmfly	*Elymnias hypermnestra*	1.13	NR	
19		Great Eggfly	*Hypolimnas bolina*	1.82	NR	
20		Common Sailor	*Neptis hylas*	1.57	NR	
21		Common Sergeant	*Athyma perius*	0.69	R	
22		Glassy Tiger	*Parantica aglea*	1.63	NR	
23		Blue Tiger	*Tirumala limniace*	0.82	R	
24		Baronet	*Symphaedra nais*	1.13	NR	
25		Common Baron	*Euthalia aconthea*	0.19	R	SCHEDULE II
26		Tawny Coster	*Acraea terpsicore*	1.63	NR	
27		Painted Lady	*Vanessa cardui*	0.06	VR	
28		Commander	*Moduza procris*	0.25	R	
29		Common Lascar	*Pantoporia hordonia*	1.57	NR	
30		Common Fivering	*Ypthima baldus*	1.69	NR	
31		Common Fourring	*Ypthima huebneri*	2.01	NR	
32		Tawny Rajah	*Charaxes bernardus*	0.13	VR	Schedule II
33		Black Rajah	*Charaxes solon*	0.06	VR	Schedule II
34		Common Map	*Cyrestis thyodamas*	0.13	VR	
35		Marbled map	*Cyrestis cocles*	0.25	R	Schedule II
36		Orange Oakleaf	*Kallima inachus*	0.06	VR	
37	Lycaenidae	Common Pierrot	*Castalius rosimon*	1.94	NR	Schedule I
38		Striped Pierrot	*Tarucus nara*	1.57	NR	Schedule II
39		Angled Pierrot	*Caleta decidia*	0.50	R	Schedule II
40		Common Cerulean	*Jamides celeno*	1.19	NR	
41		Dark Cerulean	*Jamides bochus*	0.25	R	
42		Pea Blue	*Lampides boeticus*	0.31	R	Schedule II
43		Quaker	*Neopithecops zalmora*	2.57	NR	
44		Dark Grass Blue	*Zizeeria karsandra*	1.19	NR	
45		Lesser Grass Blue	*Zizina otis*	0.88	R	
46		Pale Grass Blue	*Pseudozizeeria maha*	1.07	NR	
47		Tiny Grass Blue	*Zizula hylax*	1.63	NR	
48		Small Cupid	*Chilades parrhasius*	0.75	R	
49		Lime Blue	*Chilades lajus*	0.69	R	
50		Plains Cupid	*Luthrodes pandava*	0.63	R	
51		Gram Blue	*Euchrysops cnejus*	0.38	R	Schedule II
52		Common Lineblue	*Prosotas nora*	0.56	R	
53		Tailless Lineblue	*Prosotas dubiosa*	0.44	R	
54		Forgetmenot	*Catochrysops Strabo*	0.75	R	
55		Zebra Blue	*Leptotes plinius*	0.25	R	
56		Monkey Puzzle	*Rathinda amor*	0.31	R	
57		Copper Flash	*Rapala pheretima*	0.94	R	
58		Slate Flash	*Rapala manea*	0.75	R	
59		Common Silverline	*Spindasis vulcanus*	0.69	R	
60		Leaf Blue	*Amblypodia anita*	1.00	NR	Schedule II
61	Pieridae	Common gull	*Cepora nerissa*	2.32	NR	Schedule II
62		Striped albatross	*Appias libythea*	1.25	NR	Schedule IV
63		Common emigrant	*Catopsilia pomona*	6.39	VC	
64		Mottled emigrant	*Catopsilia pyranthe*	3.32	C	
65		Dark clouded grass yellow	*Colias fieldii*	0.75	R	
66		Psyche	*Leptosia nina*	2.38	NR	
67		Common Wanderer	*Pareronia valeria*	0.94	R	
68		Spotless Grass Yellow	*Eurema laeta*	1.32	NR	
69		One Spot Grass Yellow	*Eurema andersonii*	1.44	NR	Schedule II
70		Three Spot Grass Yellow	*Eurema blanda*	2.01	NR	
71		Small Grass Yellow	*Eurema brigitta*	2.76	NR	
72		Common Grass Yellow	*Eurema hecabe*	6.33	VC	
73	Papilionidae	Tailed Jay	*Graphium agamemnon*	1.13	NR	
74		Common Jay	*Graphium doson*	0.44	R	
75		Spot Swordtail	*Graphium nomius*	0.25	R	
76		Common Bluebottle	*Graphium sarpedon*	0.19	R	
77		Common Mormon	*Papilio polytes*	1.57	NR	
78		Blue Mormon	*Papilio polymnestor*	0.38	R	
79		Lime Butterfly	*Papilio demoleus*	0.50	R	
80		Yellow Helen	*Papilio nephelus*	0.13	VR	
81		Common Mine	*Papilio clytia*	0.50	R	Schedule I
82		Paris Peacock	*Papilio paris*	0.13	VR	
83		Common Banded Peacock	*Papilio crino*	0.13	VR	
84		Crimson Rose	*Pachliopta hector*	0.44	R	Schedule I

85		Common Rose	*Pachliopta aristolochiae*	0.69	R	
86		Common Birdwing	*Troides helena*	0.06	VR	
87	Riodinidae	Double Banded Judy	*Abisara bifasciata*	0.56	R	
88	Hesperiidae	Common Snow Flat	*Tagiades japetus*	0.75	R	Schedule II
89		Tricolour Pied Flat	*Coladenia indrani*	2.19	NR	Schedule II
90		Common Small Flat	*Sarangesa dasahara*	0.06	VR	
91		Indian Palm Bob	*Suastus gremius*	0.25	*R*	
92		Grass Demon	*Ancistroides folus*	0.25	R	
93		Chestnut Bob	*Iambrix salsala*	0.31	R	
94		Indian Skipper	*Spialia galba*	0.75	R	
95		Small Branded Swift	*Pelopidas mathias*	0.38	R	
96		Large Branded Swift	*Pelopidas subochracea*	0.31	R	
97		Common Banded Awl	*Hasora chromus*	0.38	R	
98		Common Redeye	*Matapa aria*	0.06	VR	

VC -very common (>100 sightings), C – common (51 to 100sightings), 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) [66]
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)
4.17	0.91	0.02	0.98

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	3.26	2.74	0.91	0.04	0.96	22.14
Papilionidae	2.31	2.02	0.87	0.11	0.89	7.89
Pieridae	2.27	2.7	0.91	0.12	0.88	8.02
Lycaenidae	3.00	2.53	0.94	0.02	0.94	17.11
Riodinidae	0.00	0.95	0	1.00	0.00	1.00
Hesperiidae	1.95	1.96	0.81	0.19	0.81	4.96

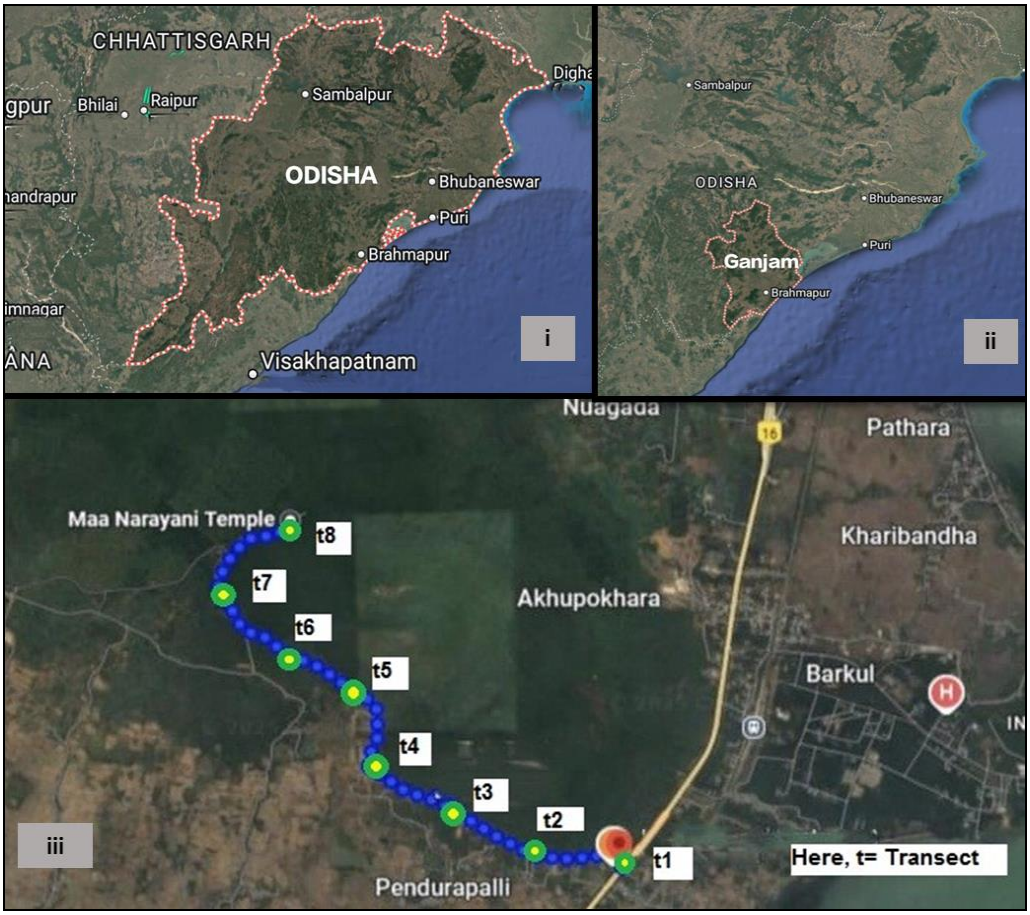

Fig 1: Satellite image of Odisha (i), Ganjam (ii) and study area (iii).

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

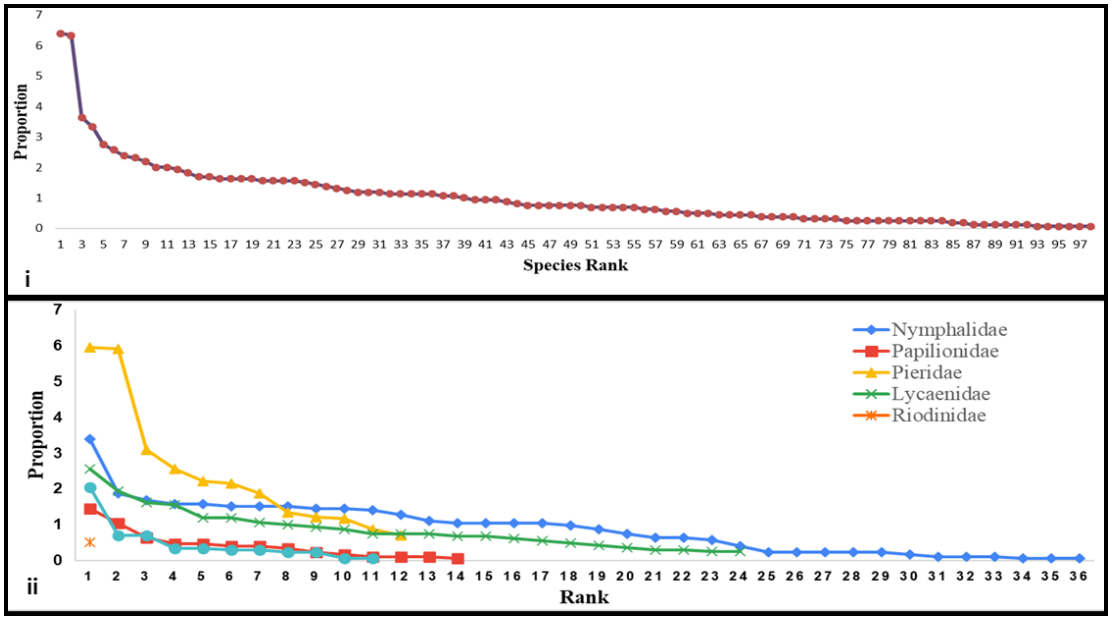

Fig 3: Rank abundance curve of 98 species of butterfly (i) and rank abundance curve of six families of butterfly (ii) in the study area

Fig 4: Photographs of different butterfly species recorded in the study area 1) *Papilio polytes*, 2) *Ypthima huebneri*, 3) *Mycalesis perseus*, 4) *Eurema hecabe*, 5) *Caleta decidia*, 6) *Polyura athamas*, 7) *Sarangesa dasahara*, 8) *Cepora Nerissa*, 9) *Neopithecops zalmora*, 10) *Castalius rosimon*, 11) *Leptotes plinius*, 12) *Tarucus nara.*

Fig 5: Photographs of different butterfly species recorded in the study area 13) *Euthalia aconthea*, 14) *Papilio demoleus*, 15) *Appias libythea*, 16) *Prosotas nora*, 17) *Lampides boeticus*, 18) *Euploea core*, 19) *Ariadne merione*, 20) *Pachliopta aristolochiae*, 21) *Hypolimnas bolina*, 22) *Tirumala limniace*, 23) *Danaus genutia*, 24) *Acraea terpsicore.*

Conclusion

The present study documented the presence of highly diverse butterfly community which signifies that the sacred grove has a healthy and ideal environment suitable for lepidopteran fauna. The data recorded in the survey might be helpful in providing reference for future studies. The butterfly population is tremendously affected by anthropogenic activities worldwide, therefore the sacred grove which act as an in-situ mode of biodiversity conservation or eco- pocket can be helpful in safeguarding the butterfly community. Human intervention is also limited in the sacred grove and its surrounding areas thus enabling ecological balance.

Reference

1. Acharya A, Pal PA. Preliminary study on the abundance of butterflies around the Chandandhara waterfall, Nabarangpur, Odisha. Journal of Entomology and Zoology Studies,2019:7(1):1431-1434.
2. Berger WH, Parker FL. Diversity of planktonic foraminifera in deep sea sediments. Science, 1970:168:1345-1347.
3. Betrus CJ, Fleishman E, Blair RB. Cross-taxonomic potential and spatial transferability of an umbrella species index. Journal of Environmental Management,2005:74:79-87.
4. Bonebrake TC, Ponisio LC, Boggs CL, Ehrlich PR. More than just indicators: a review of tropical butterfly ecology and conservation. Biological conservation,2010:143(8):1831-41.
5. Dey PK, Payra A, Mondal KA. Study on butterfly diversity in Singur, planet,2017:15(1):73-77.
6. Dutta SK, Nair MV, Mohapatra PP, Mahapatra AK. Amphibians and Reptiles of Similipal Biosphere Reserve. Regional Plant Research Centre, Bhubaneswar, Orissa, 2009.
7. Ghazanfar M, Malik MF, Hussain M, Iqbal R, Younas M. Butterflies and their contribution in ecosystem: A review. Journal of Entomology and Zoology Studies,2016:4(2):115-118.
8. Hayes L, Mann DJ, Monastyrskii AL, Lewis OT. Rapid assessments of Tropical Dung Beetle and butterfly assemblages: contrasting trends along a forest disturbance gradient. Insect Conservation and Diversity,2009:2(3):194-203.
9. Hortal J, Bello F, Diniz-Filho JAF, Lewinsohn TM, Lobo J, Ladle RJ. Seven shortfalls that beset large-scale knowledge of biodiversity. Annual Review of Ecology, Evolution and systematic,2015:46:523-549.
10. Hossain A, Aditya G. Avian Diversity in Agricultural Landscape: Records from Burdwan, West Bengal, India. Proceedings Society,2016:69(1):1-14.
11. Katuwal HB, Bhandhari J, Thapa V, Gurung R, Chaudhary R, Magar TG *et al*. How many birds do the sacred forests hold? The Journal of Zoology Studies,2016:3(4):7-19.
12. Kehimkar I. Butterflies of India, Bombay Natural History Society. Mumbai: Oxford University Press, 2016.
13. Kumar A. Butterfly abundance and species diversity in some urban habitats. International journal of Advanced Research,2014:2(6):367-374.
14. Kunte K, Sondhi S, Sangma BM, Lovalekar R, Tokekar K, Agavekar G. Butterflies of the Garo Hills of Meghalaya, NE India: their diversity and conservation. Journal of Threatened Taxa,2012:4(10):2933–2992.
15. Kunte K, Basu DN, Girish Kumar GS. Taxonomy, Systematics and Biology of Indian Butterflies in the 21st Century. In: Indian Insects: Diversity and Science, Ramani S, Mohanraj P, Yeshwanth HM (Eds). CRC Press, United Kingdom,2020.
16. MacDonald ZG, Nielsen SE, Acorn JH. Negative relationships between species richness and evenness render common diversity indices inadequate for assessing long-term trends in butterfly diversity. Biodiversity and Conservation,2017:26:617–629.
17. Mac Nally R, Fleishman E. A successful predictive model of species richness based on indicator species. Conservation Biology,2004:18:634-646.
18. Malhotra KC, Ghokhale Y, Chatterjee S, Srivastava S. Cultural and Ecological Dimensions of Sa-cred Groves in India. Indian National Science Academy, New Delhi and Indira Gandhi Rashtriya Manav Sangrahalaya, Bhopal,2001.
19. Majumder J, Lodh R, Agarwala BK. Variation in butterfly diversity and unique species richness along different habitats in Trishna Wildlife Sanctuary, Tripura, northeast India. Check List,2012:8(3):432-436.
20. Mishra S, Mohapatra PK, Sinha S, Nayak HP, Mishra AK, Nair MV *et al*. Butterflies Diversity of Nandankanan Wildlife Sanctuary, Odisha, India. E-Planet,2010:8(1):31-37.
21. Mohanta RK, Behera SK. To study on Lepidopterans (Butterfly Fauna) in the Coastal Tourism Area (CTA) of Ganjam Coast, Southern Odisha, India. International Journal of Entomology Research,2018:3(4):13-16.
22. Mulder CPH, Bazeley-White E, Dimitrakopoulos PG, Hector A, SchererLorenzen M, Schmid B. Species evenness and productivity in experimental plant communities. Oikos,2004:107:50–63.
23. Mohapatra PP, Sarkar V, Mishra AK, Nair MV. A Field Guide for Beginners: Butterflies of Bonai, Odisha. Bhubaneswar, Odisha, India: Odisha Forestry Sector Development Project, Government of Odisha, Ministry of Environment and Forests, 2012.
24. Nair MV. Three new butterfly records for Peninsular India: Dusky Yellow-Breasted Flat *Gerosis Phisara* (Moore) (Hesperiidae), Common Gem *Poritia Hewitsoni* Moore (Lycaenidae) and Great Nawab *Polyura Eudamippus* (Doubleday) (Nymphalidae) from Similipal Hills, Odisha. The Journal of Threatened Taxa,2011:3(3):1624-28.
25. Nowicki P, Settele J, Henr PY, Woyciechowski M. Butterfly monitoring methods: the ideal and the real world. Israel Journal of Ecology and Evolution,2008:54:69–88.
26. Ormsby AA., Rath S. Conservation through Traditional knowledge: a Review of Research on the Sacred Groves of Odisha, India. Human Ecology,2020:48(4):455-463.
27. Palei NC, Rath BP. 2014. Butterflies diversity of Sunabeda Wildlife Sanctuary, Odisha, India. Journal of Entomology and Zoology Studies,2014:2(2):39-44.
28. Paria S, Ghosh S, Mardaraj P, Mallick P, Chakraborty S. Habitat heterogeneity and butterfly diversity of Kuldiha Wildlife Sanctuary, Odisha, India. J Biodivers Conserv Bioresour Manag,2018:4:93-100.
29. Payra A, Das GN, Boruah B, Dash SK, Das UP, Sethy J. Butterfly diversity in two selected fringe area of

Similipal Biosphere Reserve, Odisha, India, With notes on some important sightings. Journal of Wildlife Research,2016:4(2):17-25.
30. Payra A, Dash SK, Das UP, Palei HS, Mishra AK. Butterflies of Athgarh Forest Division, Odisha, Eastern India, with notes on some significant records. Acta Biologica Sibirica,2019:5(3):188-198.
31. Pearse IS, Altermatt F. Extinction cascades partially estimate herbivore losses in a complete Lepidoptera-plant food web. Ecology,2013:94:1785–1794
32. Pyle RM. Handbook for butterfly watchers, Boston: Houghton Mifflin Harcourt, 1992.
33. Rao KR, Naik S, Patil N, Rodrigues G, Naik A, Naik A. Assessment of Butterfly (Lepidoptera: Rhopalocera) Diversity and Relative Abundance in Rivona Near the Foothills of Western Ghats-Goa. Journal of Himalayan Ecology and Sustainable Development,2021:16:69-85.
34. Robbins RK, Opler PA. Butterfly diversity and a preliminary comparison with bird and mammal diversity. In: Biodiversity II, understanding and protecting our biological resources, Wilson DE, Reaka-Kudla ML, Wilson EO (Eds.). Joseph Henry Press, Washington, DC, 1997.
35. Rodgers WA, Panwar HS. Planning a Wildlife Protected Area Network in India. Dehradun, India, FAO, 1988. https://portals.iucn.org/library/ node/25283.
36. Saxena HO and Brahmam M. The Flora of Similipal Hills, Orissa, Regional Research Laboratory, Bhubaneswar, 1989.
37. Sethy J, Jena J. Notes on Butterflies of Gudgudia range of Simlipal Tiger reserve, Orissa, India. Indian Forester,2009:135(10):1442-1445.
38. Shannon CE, Weaver W. The Mathematical Theory of Communication. Urbana: The University of Illinois Press, 1963.
39. Shrestha LJ, Devkota M. Forest Types of Pashupati Sacred Grove, Kathmandu, Nepal. Journal of Natural History Museum,2013:27:72-77.
40. Shrestha LJ, Devkota M, Sharma BK. Phyto-sociological Assessment of Sacred Groves in Kathmandu, Nepal. International Journal of Plant and Soil Science,2015:4(5):437-444.
41. Simpson GG. Species density in North American recent mammals. Systematic Zoology, 1964:3:57–73.
42. Singh A, Mohanty L, Tripathy A and Pradhan S. 2019. Study of butterfly diversity in agronomy field, OUAT, Bhubaneswar, Odisha, India. Journal of Entomology and Zoology Studies,2020:8(1):1028-1034.
43. Sutton SL, Collins NM. Insects and Tropical Forest Conservation. In: The Conservation of Insects and Their Habitats, Collins NM, Thomas JA (Eds). Academic Press, London, 1991.
44. Thomas JA. Monitoring change in the abundance and distribution of insects using butterflies and other indicator groups. Philosophical Transactions of the Royal Society B: Biological Sciences,2005:360 (1454):339-357.
45. Tiple AD, Deshmukh VP, Dennis RLH. Factors influencing nectar plant resource visits by butterflies on a University campus: implications for conservation. Nota Lepidopteralogica,2006:28:213-224.
46. Tiple AD, Khurad AM, Dennis RLH. Butterfly larval host plant use in a tropical urban context: life history associations, herbivory, and landscape factors. Journal of Insect Science,2011:11(1):65
47. Varshney RK, Smetacek P. A Synoptic Catalogue of the Butterflies of India. New Delhi: Indinov Publishing, 2015.
48. Webb KJ. Beyond Butterflies: Gardening for Native Pollinators, The University of Georgia and Ft. Valley State University, the U.S. Department of Agriculture and counties of the state cooperating. Bulletin, 1349, University of Georgia, 2008.
49. Whitaker RH. Dominance and diversity in land plant communities: numerical relations of species express the importance of competition in community function and evolution. Science, 1965:147(3655):250–260.
50. Yadav S, Yadav JP, Arya V, Panghul M. Sacred groves in conservation of plant biodiversity in Mehendergarh District of Haryana. Indian Journal of Traditional Knowledge,2010:(4):693–700.