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Studies on the butterfly diversity in selected sacred groves located in Alapad village, Thrissur district, Kerala, India

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Abstract
The present investigation was carried out to study butterfly diversity in some selected sacredgroves located in Alapad village, Thrissur district in Kerala for the period October 2020 to June 2021. In Kerala among Hindus, it was a common practice to assign a part of their land near the Tharavadu or house as the abode of goddess Durga or Serpent God Naga or Shasta and the place is called Kavu or Sarpakavu. Sacred Grove represents the major effort to recognize and conserve biodiversity (ethnic diversity) traditionally. Results showed that 40 species of butterflies representing 5 major families were recorded. Nymphalidae family showed the maximum no. of species (16species) followed by Papilionidae family (9species), Lycaenidae family (6species), Hesperiidae family (5species) and Pieridae family (4species). In conclusion, sacred groves help in the protection of many rare, threatened, and endemic species of plants and animals found in an area. This study area was rich in host plants and nectar plants. The study areas were rich in species diversity. A total of 40 species of butterflies (5 families) were recorded, among which majority was from Nymphalidae family. Out of these 40 species 22 species were commonly found throughout the period of observation in study area, 18 species were found occasionally. 7 species are protected under various schedules of the Indian Wildlife (Protection) Act, 1972.

Keywords: sacred grove, sarpakavu, biodiversity, Kerala, endemic species, hostplants

Introduction
Butterflies are one of the most colorful insects on earth. They are always a point of attraction. They play a major role with the environment as they interact with the environment as pollinators, seed disperses, herbivores, predators, and prey (K. A Sreejith *et. al.,* 2017) [4]. More than half of earth's diversity comprises insects. Among insects, butterflies play a significant role in both ecological and economic benefits to human beings. Butterflies always attract the attention of researchers, ecologists and conservationist by their community assemblage and the influencing factors (M. N. Harisha 2015) [9]. They are good biological indicators of habitat quality as well as general environment health (K. A Sreejith *et. al.,* 2017) [4]. Because of their dependence on the plants (host and nectar), butterfly diversity may reflect overall plant diversity in the given area (Anupa K Antony *et. al*., 2016) [3]. They form an important part of the food chain of birds, reptiles, amphibians, spiders and predatory insects (K. S. Aneesh *et. al.,* 2013) [6]. Kerala has rich and diverse butterfly fauna because of the availability of wide range of habitats. Thrissur is a district in the south Indian state of Kerala. It's known for sacred sites and colorful festivals. The present study was made to assess the butterfly diversity of selected sacred grooves such as Kallingal kavu, Thathapuzha kavu, Kannamkulangara Kavu, Panamukathu kavu, Perumbullikkavu, Koruthara kavu, Porumpankaatil kavu, and Variyath kavu located in Alapad village in Thrissur district. In Kerala among Hindus, it was a common practice to assign a part of their land near the Tharavadu or house as the abode of goddess Durga or Serpent God Naga or Shasta and the place is called Kavu or Sarpakavu. Sacred Grove represents the major effort to recognize and conserve biodiversity (ethnic diversity) traditionally.

Materials and methods
Study Area
The present study of butterfly diversity was carried out in a sacred groove located in Alapad village in Thrissur district. Alapad is a mid-land village in the Thrissur District of the Indian state Kerala. Alapad is situated on the Western side of Thrissur Corporation (10.4413° N, 76.1581° E). Sacred groove is rich with local plant and animal species.

Methodology
The study was carried out from October 2020 – June 2021. Observations were taken twice in a day (11- 12 am) and (4-5pm). Several species were identified while in flight, near host plant or nectar plants. Species that could not be identified were photographed and identified with the help of field guide by (K Kunte 2000) [7]. Accordingly, the observations were classified into common species which includes very common species and occasional ones which further includes rare species. The diversity and community similarities were studied using the statistical software PRIMERV7.

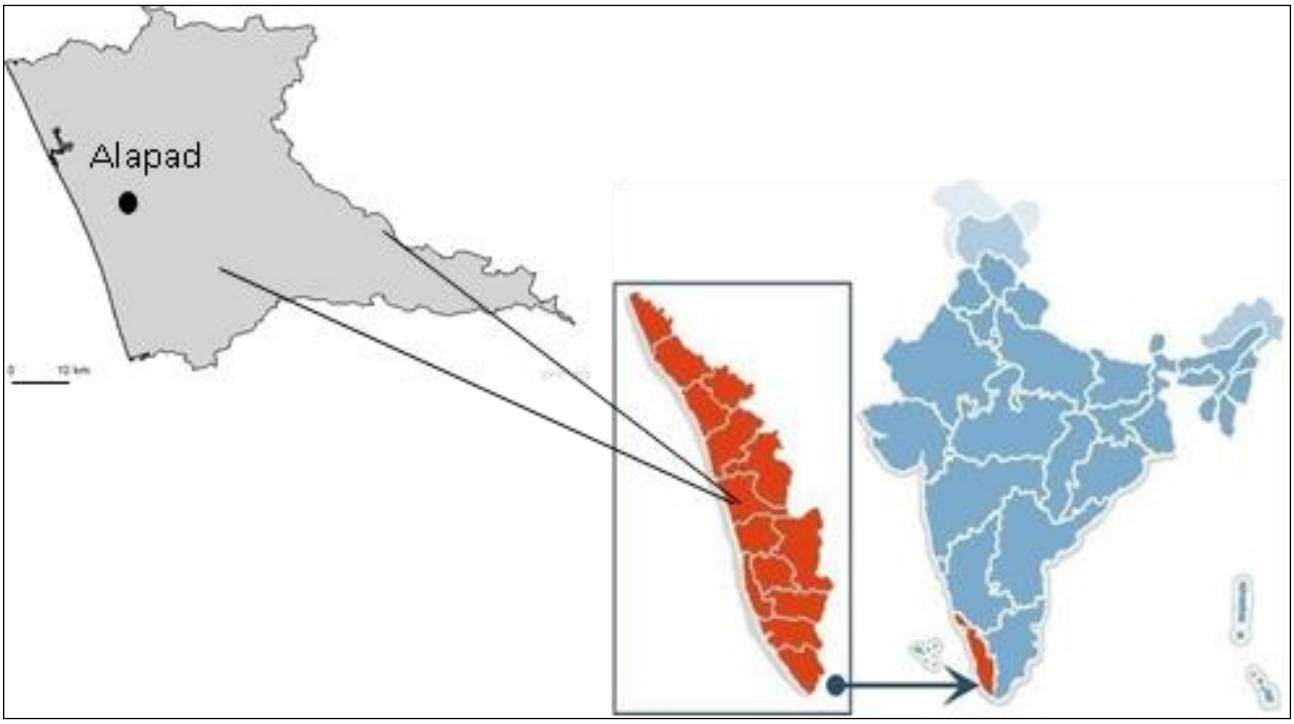

Fig 1: Locationmap of Alapadvillage, Thrissur, Kerala.

Results

Species Composition in Alapad village in Thrissur district is a total of 87 butterflies were identified from eight sites, spanning 40 taxa from five families (Table 1 & 2), representing an average of 10 or 11 specimens per sites. The species composition by family within the sacred groves of Alapad village was predominated by family Nymphalidae with 57.14% (Fig 2). Papilionidae formed the second most important group represented by 13.19%. Pieridae constituted of 13.19% and the fourth important family was the Hesperiidae, which comprised of 9.89%. Nymphalidae comprised of the majority of butterflies species (Table 1). The least numerous families were Lycaenidae with only six taxa, making up a total of 6.67%.

Family-Nymphalidae

The family Nymphalidae was the most prominent one within the sites, with a total of 52 individuals across 16 taxa, making up 57.14% of the total Butterflies. The most numerous species recorded was *Tirumala limniace* with seven individuals accounting for 13.46% of the total recorded family. The next most numerous species was *Neptis hylas*, with six individuals accounting for 11.54% of the total family. *Euthalia aconthea* was next numerous present within the sites, recording five specimens and accounting for 9.62% within the family. The rest taxa comprising of four or less individuals, accounts for a total of 65.38% of the total recorded Nymphalidae

Family- Papilionidae

The total number of observed individual Papilionidae within the sites were 12 specimens across 9 taxa, accounting for 13.19% of the total butterflies observed. *Troides minos*, *Papilio polytes*, and *Graphium agamemnon* recorded with two individuals each, that makes up for a sum of 50% of the total recorded Papilionidae.

Family- Pieridae

The family comprised of four taxa, *Catopsilia Pomona*, *Leptosia nina*, *Delias eucharis and Eurema hecabe*, recording a total of 12 individuals that makes up for a sum of 13.19% of the total recorded Butterflies.

Family- Hesperiidae

The family Hesperiidae (9.89%) comprised of five taxa, species *Erionota torus* with four, which accounts for a 4.35% of the total recorded butterflies.

Family- Lycaenidae

Family Lycaenidae (Plate 29), recording only six individuals, which accounts for 6.59% of the total recorded butterflies.

Other lepidopteran species recording less individuals can be found within Table 2

Diversity Indices

Table 2 shows the total abundance per site, number of species and their diversity indices; Margalef species richness, Pielou species evenness and the Shannon-Weiner diversity index. Altogether 40 species have been recorded from Alapad village. The Shannon Wiener index value is high at the site 7 (2.56) and it is followed by site 2 (2.31). The average of all the eight sites are 1.76, that means the moderate species diversity. The Margalef's species index value is high at site 7 (4.60) with 15 species and the lowest species richness is at site site 5 (0.91). The evenness value is high at site 8 (0.98) with six species out of seven species of the total species recorded during same site. Overall, the range of species present in all samples combined suggests a moderate level of diversity. Margalef's species richness values, in different sites, ranged from moderate (d=0.91) to rich (d=4.60), when the values ranged from moderate to rich, showing an insignificant change.

Shannon-Weiner diversity ranged from H' = 0.95 to H' = 2.56 for sites having an almost rich and diverse community. (Seen in Table2).

Community Similarities

The results of the SIMPROF analysis of the butterflies' communities at different habitats are displayed as a dendrogram in Figure 5. Similarity is seen between all the habitats within the dendrogram. It shows the overall similarity percentage (SIMPER) between different sacred groves and lists all taxa which contributed to the identified community.

The species from family Nymphalidae was the key species driving the similarity among all the sites. There were some species common in different sacred groves. Univariate diversity indices for different sacred grove sites are shown in Table 2 with figures highlighting the general butterflies community

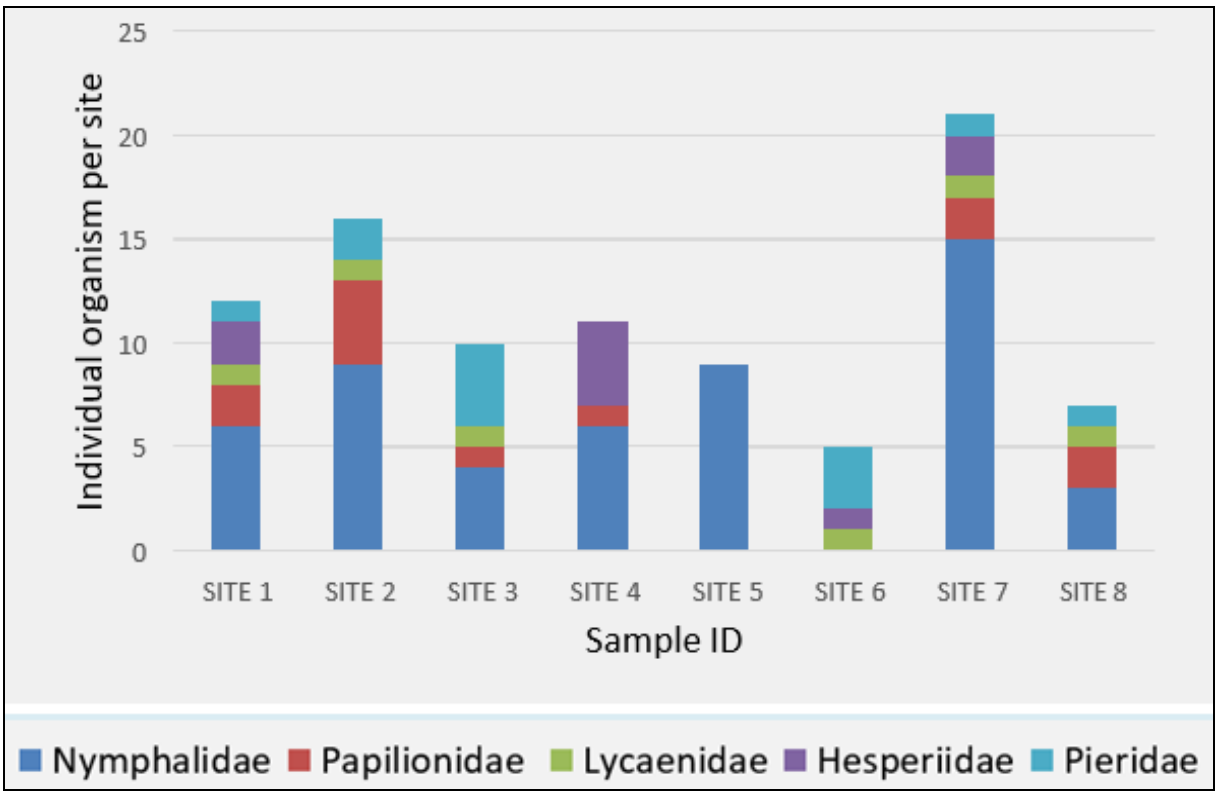

Fig 2: Site wise Population abundance of Butterflies during the study period

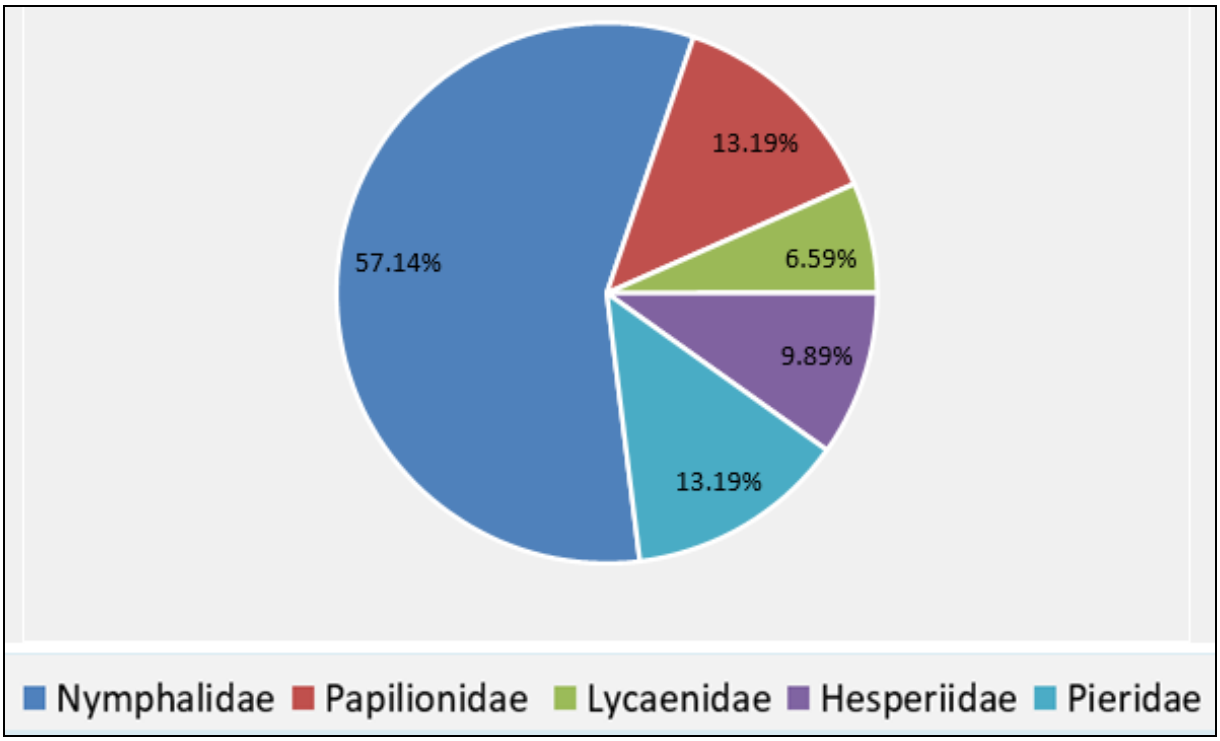

Fig 3: Family wise abundanceinthestudyarea

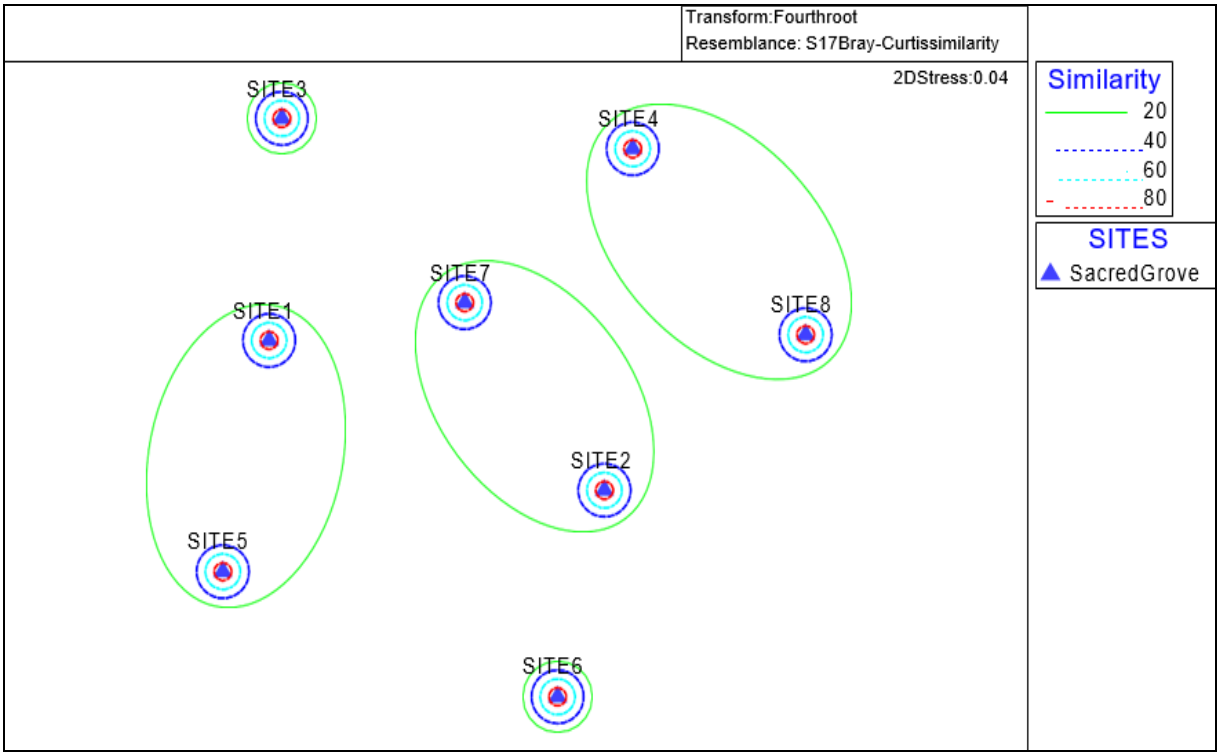

Fig 4: MD Splot of Butterfly sites (Basedon Bray-Curtissimilarity matrix, with samples colour coded to show habitat

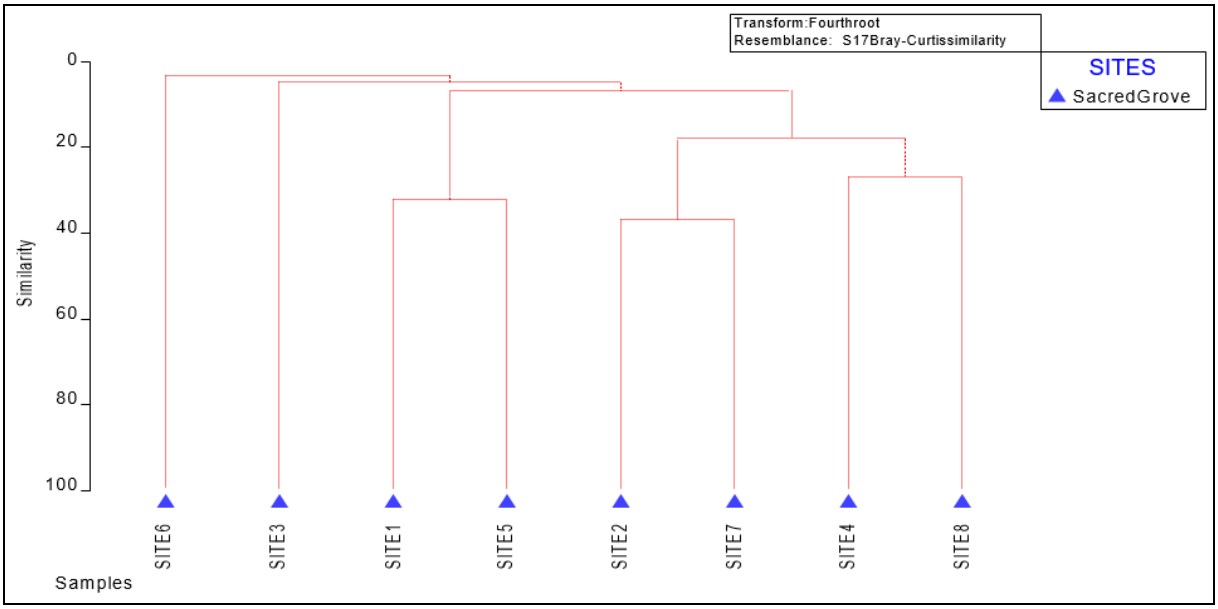

Fig 5: A dendrogram of Butterflies species by site, based on Bray-Curtis similarity

Table 1: Check list of butterflies of Alapad village along with status

Family	Scientific name	Common name	Status
Nymphalidae	*Euploea core*	Common crow	Very common
	Hypolimnas bolina	Great Eggfly	Common
	Tirumala limniace	Blue Tiger	Occasional
	Elymnias caudata	Tailed palmfly	Very common
	Acraea terpsicore	Tawny Coster	Rare
	Melanitis leda	Common Evening Brown	Common
	Tanaecia lepidea	Grey Count	Rare
	Hypolimnas misippus	Danaid Eggfly	Occasional
	Moduza procris	commander	Common
	Neptis hylas	Common sailor	Common
	Junonia atlites	Grey pansy	Occasional
	Ypthima huebneri	Common 4 ring	Common
	Euthalia aconthea	Common baron	Very common
	Junonia iphita	Chocolate pansy	Occasional

	Mycalesis perseus	Dingy bush brown	Occasional
	Ypthima baldus	Common five ring	Common
Papilionidae	*Troides minos*	Southern birdwing	Occasional
	Papilio polymnestor	Blue mormon	Common
	Papilio demoleus	*Lime butterfly*	Common
	Graphium agamemnon	*Tailed jay*	Occasional
	Pachliopta hector	*Crimson rose*	Occasional
	Graphium doson	*Common jay*	Common
	Pachliopta aristolochiae	*Common rose*	Occasional
	Papilio polytes	*Common mormon*	Very common
	Papilio clytia	*Common mime*	Common
	Castalius rosimon	*Common pierrot*	Common
	Talicada nyseus	*Red pierrot*	Rare
	Zizula hylax	*Tiny grass blue*	Occasional
	Tajuria cippus	*Peacock royal*	Occasional
	Jamides celeno	*Common cerulean*	Common
	Arhopala centaurus	*Dull oak blue*	Rare
Hesperiidae	Pelopidas mathias	*Dark small, branded swift*	Common
	Oriens gola	*Common dartlet*	Common
	Iambrix salsala	*Chestnut bob*	Occasional
	Erionota torus	*Rounded palm redeye*	Rare
	Tagiades gana	*Suffused snow flat*	Rare
Pieridae	Catopsilia pomona	*Common emigrant*	Very common
	Leptosia nina	*Psyche butterfly*	Very common
	Delias eucharis	*Common jezebel*	Very common
	Eurema hecabe	*Common grass yellow*	Very common

Table 2: Butterfly abundance and uni variate diversity indices of all sites

Site ID	No Taxa (s)	No Individuals (n)	Margalef SpeciesRichness (d)	Pielou Species Eveness (J')	Shannon- Weiner Diversity (loge)(H')
SITE 1	9	12	3.22	0.97	2.14
SITE 2	11	16	3.61	0.96	2.31
SITE 3	5	10	1.74	0.88	1.42
SITE 4	8	11	2.92	0.95	1.97
SITE 5	3	9	0.91	0.88	0.97
SITE 6	3	5	1.24	0.87	0.95
SITE 7	15	21	4.6	0.94	2.56
SITE 8	6	7	2.57	0.98	1.75
Average by site	7.5	11.4	2.6	0.93	1.76

Table 3: Species contributing to dissimilarity in the study

Species	Av. Abund	Av. Sim	Sim/SD	Contrib%	Cum.%
Euploea core	0.5	2.22	0.49	21.62	21.62
Tirumala limniace	0.56	2.15	0.5	20.96	42.58
Catopsilia pomona	0.44	1.19	0.32	11.56	54.14
Hypolimnas bolina	0.4	1.08	0.33	10.49	64.63
Neptis hylas	0.33	0.63	0.19	6.18	70.81

Table 4: Butterfly Data Sheet

Family	Species	Butterfly per site								Total
		SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	
Nymphalidae	*Euploea core*	1	1	0	0	1	0	1	0	4
	Hypolimnas bolina	2	0	1	0	0	0	1	0	4
	Tirumala limniace	0	2	0	1	0	0	3	1	7
	Elymnias caudata	1	0	0	0	0	0	0	0	1
	Acraea terpsicore	0	3	0	0	0	0	1	0	4
	Melanitis leda	0	1	0	0	0	0	0	0	1
	Tanaecia lepidea	0	0	0	1	0	0	2	0	3
	Hypolimnas misippus	0	0	0	0	0	0	1	0	1
	Moduza procris	0	0	0	1	0	0	0	2	3
	Neptis hylas	2	0	0	0	4	0	0	0	6
	Junonia atlites	0	0	0	1	0	0	0	0	1
	Ypthima huebneri	0	0	3	0	0	0	1	0	4
	Euthalia aconthea	0	1	0	0	0	0	4	0	5
	Junonia iphita	0	0	0	0	4	0	0	0	4
	Mycalesis perseus	0	1	0	0	0	0	0	0	1

	Ypthima baldus	0	0	0	2	0	0	1	0	3
Papilionidae	*Troides minos*	0	1	0	0	0	0	0	1	2
	Papilio polymnestor	1	0	0	0	0	0	0	0	1
	Papilio demoleus	1	0	0	0	0	0	0	0	1
	Graphium agamemnon	0	0	0	1	0	0	1	0	2
	Pachliopta hector	0	1	0	0	0	0	0	0	1
	Graphium doson	0	0	1	0	0	0	0	0	1
	Pachliopta aristolochiae	0	0	0	0	0	0	0	1	1
	Papilio polytes	0	2	0	0	0	0	0	0	2
	Papilio clytia	0	0	0	0	0	0	1	0	1
Lycaenidae	Castalius rosimon	*1*	0	0	0	0	0	0	0	1
	Talicada nyseus	*0*	0	0	0	0	0	0	1	1
	Zizula hylax	*0*	0	0	0	0	0	1	0	1
	Tajuria cippus	*0*	0	0	0	0	1	0	0	1
	Jamides celeno	*0*	1	0	0	0	0	0	0	1
	Arhopala centaurus	*0*	0	1	0	0	0	0	0	1
Hesperiidae	Pelopidas mathias	*0*	0	0	0	0	0	1	0	1
	Oriens gola	*0*	0	0	0	0	0	1	0	1
	Iambrix salsala	*0*	0	0	0	0	1	0	0	1
	Erionota torus	*0*	0	0	3	0	0	0	0	3
	Tagiades gana	*2*	0	0	1	0	0	0	0	3
Pieridae	Catopsilia pomona	*0*	2	0	0	0	3	1	0	6
	Leptosia nina	*0*	0	0	0	0	0	0	1	1
	Delias eucharis	*0*	0	4	0	0	0	0	0	4
	Eurema hecabe	*1*	0	0	0	0	0	0	0	1
Total number of individual butterflies		**12**	**16**	**10**	**11**	**9**	**5**	**21**	**7**	**91**
Total number of taxa per site		**9**	**11**	**5**	**8**	**3**	**3**	**15**	**6**	

Discussion and conclusion

40 species from 5 families were reported from 8 different sacred grooves located in Alapad village in Thrissur district. The diversity and abundance of species is highly correlated with the availability of food plants in the surroundings (Kunte 2000) [7]. Among these 40 species two species (common pierrot, crimson rose) are in Schedule I, four species (peacock royal, grey count, danaid eggfly, common mime)

are in Schedule II, one specie (common crow) in Schedule IV as per Indian Wildlife Protection Act, 1972. A total of 40 species of butterflies (5 families) were recorded among which majority was from Nymphalidae family. The Nymphalids, the largest group of strong bodied butterflies with colourful wings. Nymphalidae family showed the maximum no. of species (16 species) followed by Papilionidae family (9 species), lycaenidae family (6species), Hesperiidae family (5species) and Pieridae family (4species). A similar pattern of predominance of Nymphalids was also reported by different researchers (C. Sneha, 2018; M. N. Harisha 2015; K. S. Aneesh *et. al.*, 2013) [1, 9, 6]. Out of these 40 species 22 species were commonly found throughout the period of observation in study area, 18 species were found occasionally. The checklist of all the species observed with their status are given in Table 1. More number of species were found in the month of April. From these datas we concluded that, sacred groves help in the protection of many rare, threatened, and endemic species of plants and animals foundin an area. This study area was rich in host plants and nectar plants. The study areas were rich in speciesdiversity. A total of 40 species of butterflies (5 families) were recorded, among which majority was from Nymphalidae family. Out of these 40 species 22 species were commonly found throughout the period of observation in study area, 18 species were found occasionally. 7 species are protected undervarious schedules of the Indian Wildlife (Protection) Act, 1972.

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