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Emerging from adversity: Factors influencing the roosting behaviour & plant-species interaction of different butterfly species in a modified urban park in West Bengal, India

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Abstract
Roosting behaviour in butterflies remains understudied, particularly in the Indian subcontinent. This study, conducted in the Eco-tourism Park Butterfly Garden, West Bengal, India, documented butterfly roosting patterns, habitat preferences, and plant associations over three months (January-March 2021). A total of 659 individuals from 24 species across five families were recorded, with *Lycaenidae* being the most abundant. Roosting heights ranged from 0.1 to 6.1 m, with most butterflies preferring lower heights (0.1-1 m). Leaves were the preferred perch (66%), and butterflies predominantly roosted near vegetation, within 0.8-1.4 m of flowering patches. Roosting sites maintained cooler, drier conditions, influenced by temperature and humidity. Twenty-one plant species were used as roosting sites, with *Cuphea hyssopifolia* and *Kyllinga monocephala* being most preferred. Larger species exhibited both solitary and communal roosting. These findings highlight the importance of plant selection and microhabitat conditions in butterfly conservation efforts.

Keywords: *Lepidoptera*, microhabitat, habitat utilisation, roosting, human-dominated landscape

Introduction
In the animal kingdom, roosting is a condition of decreased activity that culminates in the migration of individuals marking the end of the day. The study of roosting is very common in the avian community (Chang *et al.*, 2020) [1] and it has also been studied in mammals (Mallet, 1986) [2]. For insects and butterflies, it has not been studied extensively. Most butterflies land either gregariously or alone on plant perches to rest each night, which is an intriguing nocturnal phenomenon for diurnal species and vice versa (Auddy *et al.*, 2021) [3]. The most limiting constraints in selecting microhabitats for butterfly roosting or hibernation sites are frequently larval host plants and nectar plants. For more than a century, these behaviours have been seen in various insect taxa, including moths, dragonflies, bees, and wasps (Salcedo, 2010) [4]. In each instance, researchers have put out many theories, most of which entail significant modifications (*e.g.*, Brower *et al.*, 2008) [5]. These aggregations can be permanently synchronized or based on seasonal variations and circadian rhythm (Waller and Gilbert, 1982) [6]. Aggregation conduct can be categorized based on several factors, including the number of individuals fighting for a single position. Certain butterfly species take breaks in strange locations at times of day which is not usual or ideal for them while travelling to their intended destination (Devries *et al.*, 1987) [7].
In comparison to other species, butterflies spend 12-13 hours a day roosting (Finkbeiner, 2014) [8]. The winter congregation *i.e.*, the communal roosting pattern may serve as a thermal buffer against the study site's low nighttime temperatures, which may eventually cause the roosting site's microclimate to shift to a more comfortable temperature and humidity level (Brower *et al.*, 2008; Salcedo, 2010) [5,4]. The everyday activities of individuals within a butterfly community maintain a temporal pattern in their behaviour, which is then influenced by the characteristics of the population (Lambkin, 2016) [9]. Individual fitness is largely determined by the choice of location and roosting behaviour (Fischer *et al.*, 2004) [10]. This ultimately determines an individual's need for energy and ability to evade predators (Chang *et al.*, 2020) [1]. *Lepidoptera* roosts are typically found in low, dense vegetation

(such as grasses, bushes, *etc*.), sheltered areas (such as under leaves, branches, or stone outcrops, or in cave-like hollows), and species-specific roosting substrates (Devries *et al.*, 1987; Davis *et al.*, 2012) [7, 11]. When it comes to crucial habitats for butterflies, the majority of attention has been focused on plants that serve as larval hosts and sources of food or nectar, largely ignoring other crucial habitats such as roosting sites that are vital to the survival and population of butterflies. (Dennis, 2004) [12].

In India, no prolonged studies have been conducted that entirely focus on the roosting behaviour in butterflies other than a few occasional records of communal roosting from various landscapes (Tigers *et al.*, 2014; Patil, 2016; Seal *et al.*, 2020) [13, 14, 15].

To fill this gap in butterfly research, our objective for this study was to explore an unexplored behaviour among butterflies, especially in the Indian sub-continent as well as to create a baseline information about the roosting behaviour. With this study, we also aim to establish the role of intrinsic associations between plants and butterflies which plays a pivotal role in understanding the ecology of the species.

2. Materials & methods

This study was done in the Eco-tourism Park Butterfly Garden (22.608086 °N, 88.465236 °E) in the North 24 Parganas district of West Bengal, India. To assist research projects with an established laboratory and raise public awareness of the value of butterflies and other species, this butterfly conservatory was developed in 2015 (Fig 1). More than 100 species of trees, herbs, shrubs, and grasses can be found together in the habitat which consists of a rather small area of 0.012 sq. km.

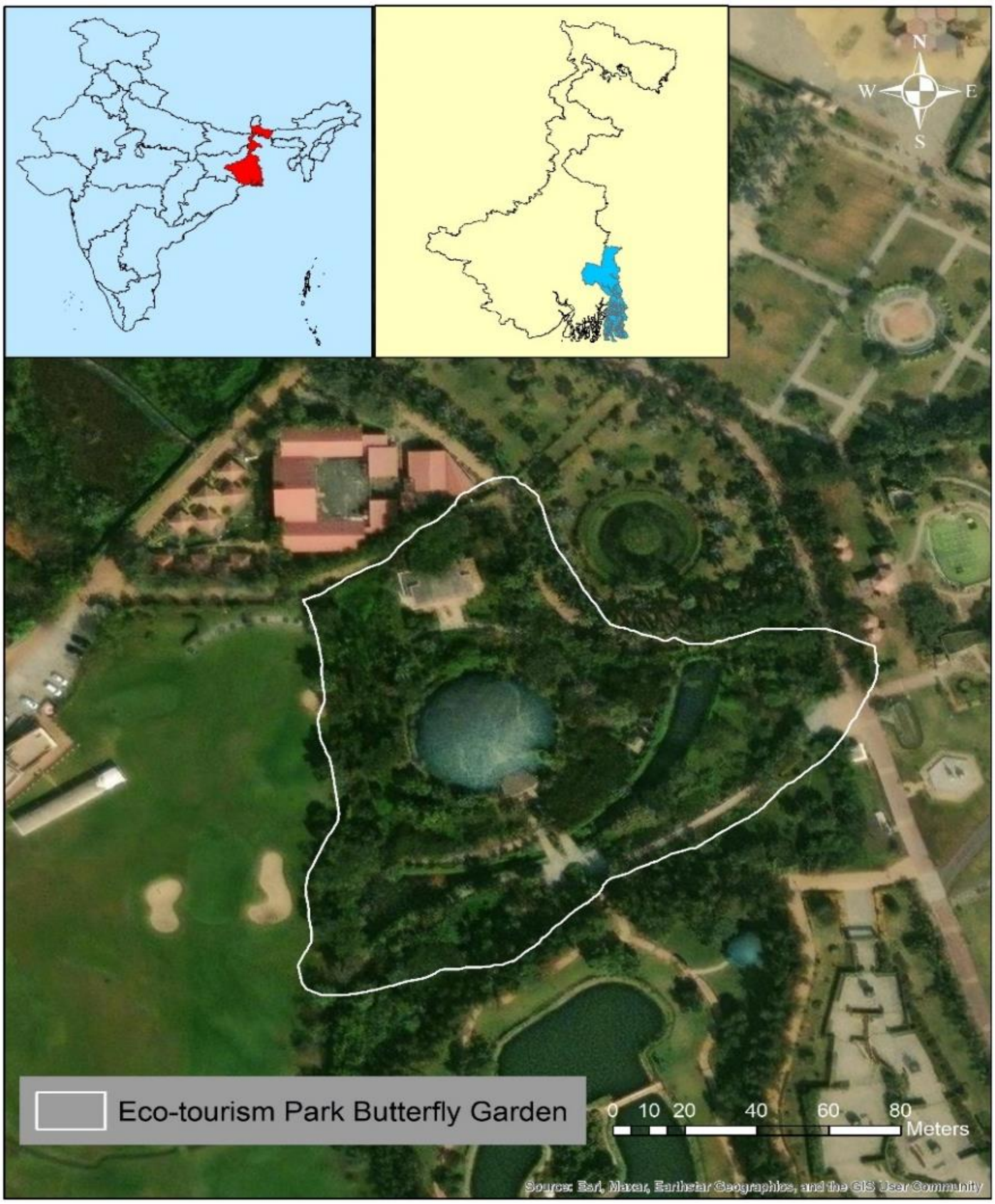

Fig 1: Map showing the location of the study area inside an urbanized tourism park in West Bengal, India

2.1. Roosting Butterfly Population

During the winter, from January to March 2021, six days a week (except Monday) were dedicated to conducting the roosting butterfly survey. Beginning at approximately 4:30 p.m., the survey was completed by 7:00 p.m. The total count method (Lewis, 1970) [16] was opted for the roosting survey and determination of the population. Every single individual directly sighted was taken into account. Every day, survey of every microhabitat was conducted to see the butterflies roosting. Since the study period fell during the winter, when butterflies are most elusive, much care and attention were given to finding each butterfly that was roosting. In addition, every day, the entire research area was inspected under a flashlight to locate every roosting individual.

2.2. Plant-Butterfly Association

For this study, every butterfly seen during the roosting survey was considered, and the types of plants (such as trees, herbs, shrubs, or grass) that the butterflies used to rest and lessen their activity were noted. Using a torch light, the roosting plant species of each roosting data set were gathered. Occasionally, a digital camera was utilized to take images and identify the precise roosting plant species because of the distance and visual blur of the butterfly roosting spot.

2.3. Assessment of Environmental Factors

Environmental factors whether biotic or abiotic were determined during every survey for every individual sighted. Biotic factors like roost plant height, distance to the nearest flowering patch, and distance to the nearest light source were measured in feet. Tree heights were taken from the vegetation survey on each microhabitat including all the plantations. These factors were measured closer to the roost spot which is referred to as "inside roost" and the same measurements were taken away from the plant canopy which is referred to as "outside roost". This was used to determine the impact of the environmental factors in the roosting site selection and the behaviour of the butterflies.

2.4. Vegetation Survey

The vegetation survey was done while considering all major variables starting from GBH, tree height, canopy shape, the shape of leaves, number of primary, secondary, and dead branches, and plants nearest to them in all four cardinal directions. The GBH of the tree *i.e.*, girth at breast height was measured by measuring tape (Blozan, 2006) [17] and the tree height was determined by the range finder. Visual encounter method was followed while counting the number of primary, secondary, and dead branches. For determining the nearest plant species from each major plant in four cardinal directions, four quadrants were created from the plant species (each direction one quadrate), and the nearest plant species distance in each direction (quadrate) was taken. While surveying the tree species only the nearest tree species was taken in each quadrate and the same was done for herbs, shrubs, and grasses as the nearest of the same species were taken in each quadrate (Krebs, 1999) [18].

2.5. Statistical Analysis

Different roosting butterfly population characteristics, habitat characteristics, and abiotic factors were assessed. The descriptive statistics *i.e.*, mean and standard errors were calculated for all the replicative variables. Generalized Linear Models were carried out by taking the roosting butterfly population, roosting height (m), distance to nearest flowering patch (m), temperature (°C) inside the roost, temperature (°C) outside the roost, humidity (%) inside the roost, and humidity (%) outside the roost, as the dependent variables and the microhabitats as independent factors. Multiple regression models adopting step-up and step-down procedures were developed to investigate the factors influencing the roosting butterfly population. The categorical variables were used as dummy/dichotomous variables in the analyses. The statistical procedures were followed based on Nagarajan and Thiygesan (1996) [19] and Nagarajan *et al.*, (2002a, 2002b, 2002c) [20, 21, 22]. The significance levels used were 0.05, 0.01, and 0.001. The statistical inferences were made using Sokal and Rohlf (1995) [23] and Zar (1999) [24].

3. Results & Discussion

3.1. Roosting Butterfly Species

During the study, from January 2021 to April 2021, 659 individuals of various butterfly species were noted. Twenty-four species of butterflies belonging to five distinct families were observed among these. The Wild Life (Protection) Act of 1972 does not identify any butterfly species discovered in this study; they were all designated as unscheduled, even though their numbers have decreased. Only one of the twenty-four species that were found during the study period is classified as Least Concerned (LC) by the IUCN, while the remaining species are classified as Not Evaluated (NE) on a worldwide scale. Butterflies are usually diurnal and among these, no migrant was reported and all the species found in this period follow the same characteristics. Lycaenids or the small blue butterflies were the most abundant as the study was done in the winter season and Lycaenids are found more in number than other species. Among those 24 different species, one was from Papilionidae (lowest), three species from the *Pieridae* family, seven from the family *Nymphalidae*, ten belonged to the *Lycaenidae* family (highest), and three species from the *Hesperiidae* family.

3.2. Roost Height Selection: The variation in the usage of roost height by different individuals of butterflies is shown in Figure 2. Various butterfly species roosted at heights ranging from 0.1 to 6.1 m. Most of the individuals were found to roost between 0.1-0.5 m. This was most likely dependent on their size as well as their surroundings. Out of 659 individuals around 400 individuals were rested at the range of 0.5-1 m (excluding a few occasions). From the raw data, it is inferred that most of them belong to the family *Lycaenidae*. They are the smallest among all the other families of butterflies and hence can be said that they roost in relatively lower heights than other species as it varies with the amount of energy spent. Very similar in size in the case of *Hesperiidae* but slightly larger than Lycaenids have been seen to roost a little higher and this hierarchy continues as the species size gets bigger. The larger the species higher their height of roosting. Most species of butterflies utilized a height of 0.3 m and frequently used up to 1 m. The highest roost was observed at 6.1 m and occasionally used from 4.6-5.7 m height to roost (Fig 2).

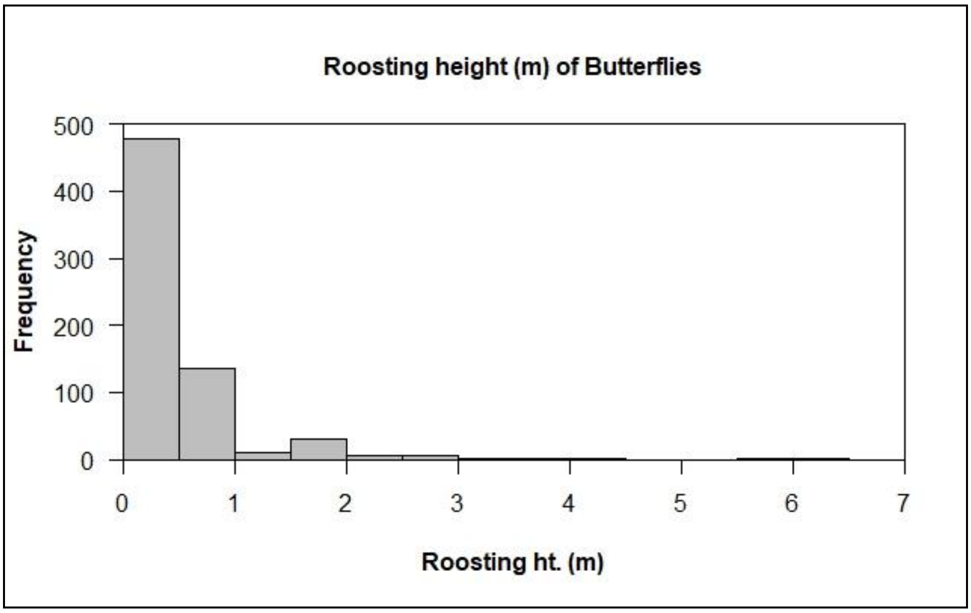

Fig 2: Roosting height selection among different individuals of butterflies in Eco-tourism Park, the North 24 Parganas district of West Bengal, India from January 2021 to April 2021

3.3. Roost Perch Selection

The different perch substrates *i.e.*, dead branch, dead leaf, flower, fruit, inflorescence, leaf, main branch, stem, and under leaf used by different species of butterflies are given in Table 1. Among these observations, certain Lycaenids (*i.e.*, *Zizina otis*) were seen mostly to use the highly used roosting substrates. Among all 659 individuals sighted during this study, more than 66% (437 out of 659) were sighted perching on leaves. The second most used site was flower with over 18% and they used dead branches over 10% which included most individuals. The individuals were scattered and were observed roosting in different varieties of sites or different parts of the plants (Table 1).

Table 1: Roosting perch selection among different species of butterflies in Eco-tourism Park, the North 24 Parganas district of West Bengal, India from January 2021 to April 2021.

Butterflies Species	Dead branch	Dead leaf	Flower	Fruit	Inflorescence	Leaf	Main Branch	Stem	Under leaf	Over All
Ampittia dioscorides	0	0	0	0	0	2	0	0	0	2
Anthene lycaenina	0	0	0	0	0	1	0	0	0	1
Appias olferna	0	0	6	0	0	1	0	0	0	7
Ariadne merione	0	0	0	0	0	2	0	0	3	5
Catochrysops strabo	0	0	0	0	0	9	0	0	1	10
Chilades pandava	0	0	0	0	0	4	0	0	0	4
Curetis thetis	0	0	0	0	0	0	0	0	7	7
Danaus chrysippus	5	0	0	0	1	1	0	0	0	7
Danaus genutia	3	0	0	0	0	11	1	0	0	15
Eurema hecabe	0	0	0	0	0	1	0	0	3	4
Leptosia nina	0	0	0	0	0	1	0	0	0	1
Matapa aria	0	0	0	0	0	1	0	0	0	1
Melanitis leda	0	0	0	0	0	6	0	0	0	6
Moduza procris	0	0	0	0	0	0	0	0	3	3
Mycalesis spp.	0	1	0	1	0	16	0	0	0	18
Papilio demoleus	0	0	0	0	0	1	0	0	1	2
Prosotas nora	1	1	0	0	0	1	0	0	0	3
Pseudozizeeria maha	0	0	0	0	0	2	0	0	0	2
Spalgis epius	0	0	0	0	0	2	0	0	0	2
Tarucus spp.	0	0	1	0	0	0	0	0	0	1
Telicota sp.	0	0	0	0	0	1	0	0	0	1
Ypthima huebneri	0	0	3	0	0	10	0	0	0	13
Zizeeria karsandra	4	0	9	0	0	7	0	0	0	20
Zizina otis	57	1	103	5	0	357	0	1	0	524
All	70	3	122	6	1	437	1	1	18	659

3.4. Distance to Nearest Flowering Patch from Roost

The distance to the flowering patch from the butterfly roosting sites are shown in Figure 3. This variable indicates the relation of vegetation with the site selected for roosting among different individuals of different species. From this graph, it can be rightly said that butterflies choose plants or roost sites based on the vegetation available near them. That not only will enable them to camouflage themselves but will also increase their habitat options for roosting. Here, more than 95% of the individuals were seen to roost nearby (within 0.8-1.4 m) with other vegetation (whether flowering or non-flowering) which proves that the butterflies choose their roosting habitat keeping in mind all the adverse variables that might affect their roosting behaviour. Most roosts were 1.4 m away and occasional roosts were 3-4.6 m away from the flowering patch (Fig 3).

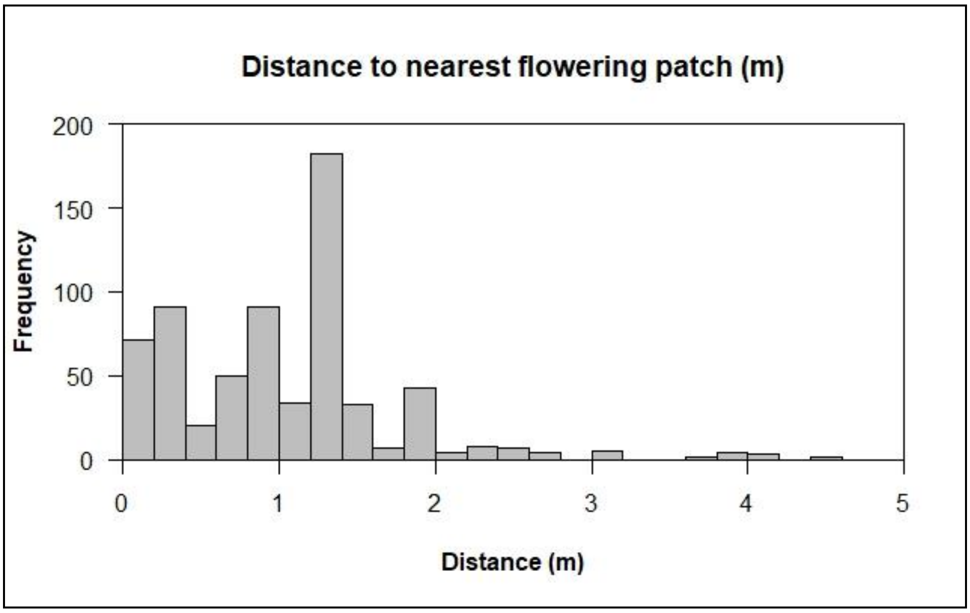

Fig 3: Distance to nearest flowering patch from the site of butterfly roosting in Eco-tourism Park, the North 24 Parganas district of West Bengal, India from January 2021 to April 2021

3.5. Effect of Atmospheric Temperature on the Roosting of Butterfly: The temperature inside and outside of the butterfly roosting sites are shown in Figure 4. This graph clearly shows considerable difference between the atmospheric temperature inside and outside the roost. In this study, the temperatures fluctuated from 19 °C to as high as 35 °C which suggested that butterflies need relatively cooler surroundings to roost and reduce their activity (Fig 4).

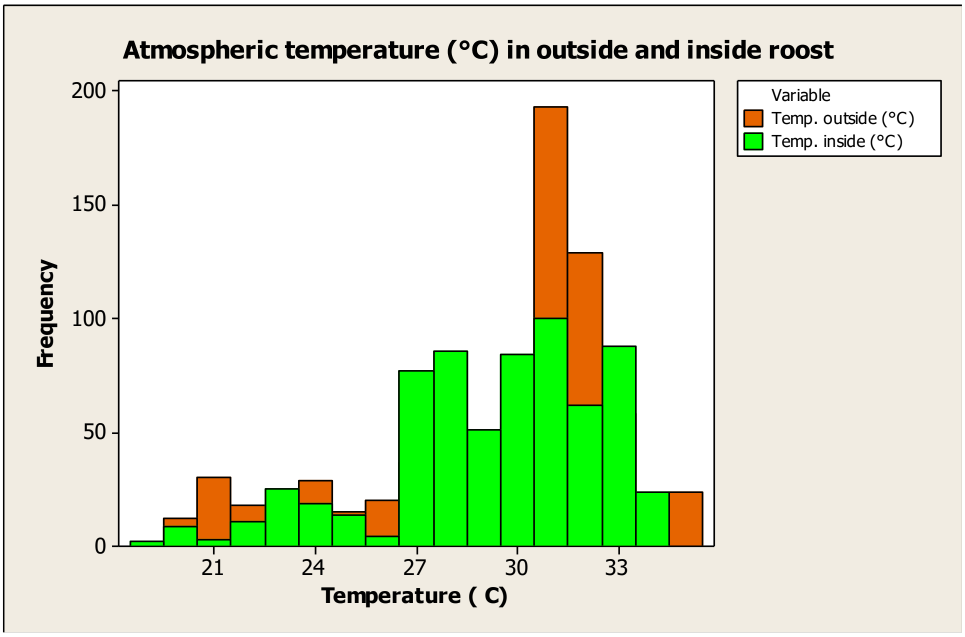

Fig 4: Comparison of atmospheric temperature outside and inside roost of Butterfly in Eco-tourism Park, the North 24 Parganas district of West Bengal, India from January 2021 to April 2021

The variations in the temperature inside and outside of the butterfly roosting sites and fitted line plots are shown in Figure 5. The inside temperature of roosts was influenced by the outside temperature cubically. The influence of outside temperature up to 23 °C, the slope is shallow *i.e.* outside temperature influenced the inside temperature of the roost marginally. From 24-30 °C slope is accelerating *i.e.* outside temperature started to influence the inside temperature of the roost steadily. Above 32 °C slope is deep *i.e.* outside temperature strongly influences the inside temperature of the roost. 58.5% of the total variations in the temperature inside the roost were explained by this cubic effect of outside temperature (Fig 5).

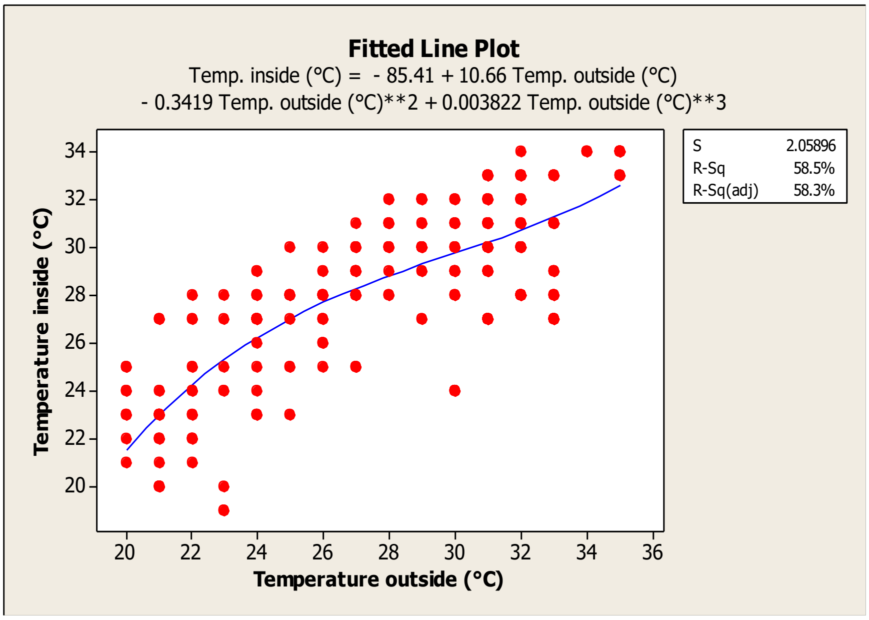

Fig 5: Comparison in the temperature between inside and outside roost observed in Eco-tourism Park, the North 24 Parganas district of West Bengal, India from January 2021 to April 2021

3.6. Effect of Humidity on the Roosting of Butterfly

The humidity inside and outside of the butterfly roosting sites are shown in Figure 6. This study also clearly emphasizes that abiotic factors like light, temperature, humidity, and others have a major role in the roosting behaviour of butterflies. If a particular site or perch has proper temperature and humidity it serves as the perfect place for the butterflies to roost. Here in this study, humidity outside the plant was much higher (up to 68%) and inside was much lower in most of the cases with most being 58%. Whereas the minimum humidity observed outside roost plants was around 22% and inside was a mere 10% which indicated that butterflies preferred a relatively less humid atmosphere around them to roost. Most roosts had 24-30% and frequently used up to 42% and outside humidity varied up to 68%. Butterfly used the roots which occasionally had humidity of 46-58%. Mostly the inside humidity was lower than outside humidity (Fig 6).

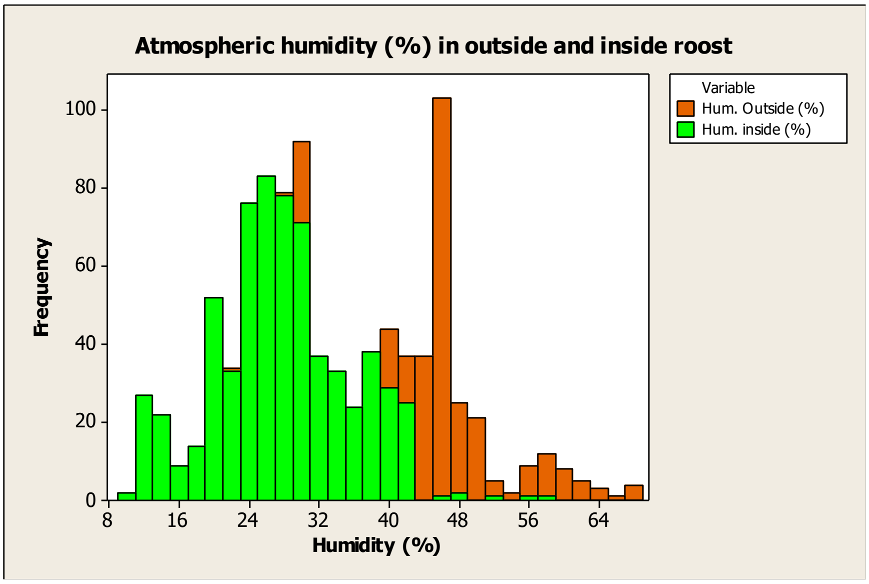

Fig 6: Comparison of humidity between outside and inside roost observed in Eco-tourism Park, the North 24 Parganas district of West Bengal, India from January 2021 to April 2021

3.7. Plant-Butterfly Interaction: The most common places for roosting were under trees, near bushes and herbs. Grasses were also used by the butterflies. Lycaenids almost always used the shrub *Cuphea hyssopifolia* to their maximum potential. The grass species *Kyllinga monocephala* was the next most used plant, followed closely by *Cuphea hyssopifolia*, which was likewise mostly used by lycaenids. *Wedelia chinensis*, *Mikania micrantha*, and *Ageratum conyzoides* were three more significant species utilized as roosting grounds. *Samanea saman*, *Butea monosperma*, and *Polyalthia longifolia* were the most commonly used tree species. (Table 2).

Table 2: Number and percentage of plant species used for roosting by different families of butterflies in Eco-tourism Park, the North 24 Parganas district of West Bengal, India from January 2021 to April 2021.

Roosting plant sp.	*Hesperiidae*	*Lycaenidae*	*Nymphalidae*	Papilionidae	*Pieridae*	Overall
Ageratum conyzoides	0	80	4	0	7	91
Bauhinia purpurea	0	0	2	0	0	2
Butea monosperma	0	16	6	0	0	22
Crotalaria sp.	0	5	2	0	0	7
Cuphea hyssopifolia	0	188	2	0	0	190
Cynodon dactylon	0	1	0	0	0	1
Heliconia rostrata	0	0	4	1	0	5
Imperata cylindrica	0	1	0	0	0	1
Kyllinga monocephala	0	160	3	0	0	163
Mangifera indica	0	0	1	1	0	2
Michelia champaca	0	0	1	0	0	1
Mikania micrantha	3	57	10	0	3	73
Phyllanthus sp.	0	0	2	0	0	2
Polyalthia longifolia	0	7	1	0	0	8
Pongamia pinnata	1	1	1	0	0	3
Samanea saman	0	0	7	0	0	7
Setaria megaphylla	0	0	1	0	0	1
Thespesia populnea	0	0	3	0	0	3
Wedelia chinensis	0	48	25	0	2	75
Ziziphus sp.	0	2	0	0	0	2
All	4	566	75	2	12	659

The frequency occurrences of different species of plants used for roosting by butterflies are given in Table 3. The shrub *Cuphea hyssopifolia* was used maximum which was used 190 times and almost in all cases by lycaenids. The next most used plant was a grass species *Kyllinga monocephala* which was used 163 times to roost and the same as *Cuphea hyssopifolia* which was also mostly used by lycaenids. Other important species used for roosting were *Ageratum conyzoides*, *Mikania micrantha*, and *Wedelia chinensis* with 91, 73, and 75 times respectively (Table 3).

Table 3: Plant species used for roosting by butterflies in Eco-tourism Park, the North 24 Parganas district of West Bengal, India from January 2021 to April 2021.

Roosting plant species	No. of instances	Percentage (%)
Ageratum conyzoides	91	13.81
Bauhinia purpurea	2	0.3
Butea monosperma	22	3.34
Crotalaria sp.	7	1.06
Cuphea hyssopifolia	190	28.83
Cynodon dactylon	1	0.15
Heliconia rostrata	5	0.76
Imperata cylindrica	1	0.15
Kyllinga monocephala	163	24.73
Mangifera indica	2	0.3
Michelia champaca	1	0.15
Mikania micrantha	73	11.08
Phyllanthus sp.	2	0.3
Polyalthia longifolia	8	1.21
Pongamia pinnata	3	0.46
Samanea saman	7	1.07
Setaria megaphylla	1	0.15
Thespesia populnea	3	0.46
Wedelia chinensis	75	11.39
Ziziphus sp.	2	0.3
N=	659	100

A total of 21 plant species were used by five different families of butterflies. Lycaenids used most of the plant species and among the plants, *Cuphea hyssopifolia* was used maximum. Papilionidae used a few plants only.

Table 4 emphasizes the roost plant with different phonological characteristics selected by the butterfly species. Here, butterflies selected mostly plants with flowers to roost (335 out of 659). One plausible reason for this could be that in the morning after waking up they should find food resources near them as it will take some time to get active and forage. But on the contrary 315 of them have chosen plants without flowers. This behaviour could be to avoid crowds but this needs further research to conclude (Table 4).

Table 4: Number and percentage of plants used with different phenology by various species of butterflies in Eco-tourism Park, the North 24 Parganas district of West Bengal, India from January 2021 to April 2021.

Name of Butterflies	With Flowering	Non-Flowering	With Fruits	Leaves	Over All
Ampittia dioscorides	0	2	0	0	2
Anthene lycaenina	0	1	0	0	1
Appias olferna	6	1	0	0	7
Ariadne merione	0	5	0	0	5
Catochrysops strabo	0	9	0	1	10
Chilades pandava	0	4	0	0	4
Curetis thetis	0	7	0	0	7
Danaus chrysippus	0	6	0	1	7
Danaus genutia	0	10	0	5	15
Eurema hecabe	1	3	0	0	4
Leptosia nina	1	0	0	0	1
Matapa aria	0	1	0	0	1
Melanitis leda	4	2	0	0	6
Moduza procris	2	0	0	1	3
Mycalesis spp.	5	13	0	0	18
Papilio demoleus	1	1	0	0	2
Prosotas nora	1	1	1	0	3
Pseudozizeeria maha	0	2	0	0	2
Spalgis epius	0	2	0	0	2
Tarucus spp.	1	0	0	0	1
Telicota sp.	0	1	0	0	1
Ypthima huebneri	5	8	0	0	13
Zizeeria karsandra	14	6	0	0	20
Zizina otis	294	230	0	0	524
All	335	315	1	8	659

4. Conclusion

Different butterfly species roosted at heights ranging from 0.1-6.1 m. Most of the individuals were found to roost between 0.1-0.5 m and the heights varied from 1-6.1 m depending on the species. This suggested that roosting height was correlated with body size and thus attributed to searching behaviour where resources were limited (Pearson and Anderson, 1985) [25]. *Zizina otis* belonged to *Lycaenidae* and was seen mostly to use all roosting substrates. Among all 659 individuals sighted during this study, more than 66% were sighted perching on leaves. The second most used site was a flower with over 18%. The butterflies used dead branches with over 10% which included most of the individuals who determined that selection of roosting site and roosting behaviour played an important role in determining individual fitness (Fischer *et al.*, 2004) [10].

In this study, the temperatures fluctuated from 19 °C to as high as 35 °C which suggested that butterflies need relatively cooler surroundings to roost and reduce their activity as there was a significant difference found between the atmospheric temperature inside and outside the roost plant and individual butterfly species and families prefer different temperatures for roosting (Clevenger *et al.*, 2001) [26]. Other abiotic factors like light, humidity, and others have a major role in the case of the roosting behaviour of butterflies (Brower *et al.*, 2008) [5]. Most roosts had 24-30% and frequently used up to 42% and outside humidity varied up to 68%. Butterflies used the roosts which occasionally had humidity of 46-58% which states that most of the individuals whether solitary or communal, used less humid substrates while roosting thus increasing the population in those areas (Dennis, 2004) [12]. If a particular site or perch has proper temperature and humidity, it is the perfect place for the butterflies to roost (Chowdhury *et al.*, 2017) [27].

The shrub *Cuphea hyssopifolia* was used maximum which was used 190 times and almost in all cases by lycaenides. The next most used plant was a grass species *Kyllinga monocephala* which was used 163 times to roost and the same as *Cuphea hyssopifolia* which was also mostly used by lycaenides. Other important species such as *Ageratum conyzoides*, *Mikania micrantha*, and *Wedelia chinensis* showed that roosting butterflies have a significant relationship with the vegetation surrounding them (Davis *et al.*, 2012) [11]. One probable explanation for this behaviour is that the number of smaller butterflies (Lycaenids) during the winter season influences their resource partitioning, resulting in the utilisation different plant species for roosting (Chang *et al.*, 2020) [1]. In contrast, Nymphalids, the larger butterflies, exhibit both communal and solitary roosting in winter. Thus, plants having ideal surfaces for both types of roosting and keeping themselves warm and safe from predators will be preferred in the case of Nymphalids (Finkbeiner *et al.*, 2012) [28].

Catochrysops strabo and *Curetis thetis* were observed on the same plant species and on same substrate throughout the observations. Both species were Lycaenids, and they roosted on tall trees like *Butea monosperma* and *Polyalthia longifolia*. They demonstrated site fidelity and preference for a specific site since it offered as a secure shelter for multiple days, and less rivalry for the site could be a contributing factor (Dos Santos, 2013) [29]. The presence of Lycaenids resulted in a greater variety of plants, shrubs, and grasses such as *Mikania micrantha*, *Wedelia chinensis*, *Cuphea hyssopifolia*, and *Kyllinga monocphala*, and their short heights provided excellent roosting habitat (Davis *et al.*, 2012) [11].

The leaf was mostly used since it can be found in all groups of plants, whether herbs, shrubs, or trees in winter. Flowers are less common than leaves since there are fewer flowering plants. Thus, leaves stood out among other substrates and were used several times (Fischer *et al.*, 2004) [10]. Butterflies were seen to roost on several types of plants and different

portions of the plants, determining the type of habitat required for them to rest more in a specific area (Devries *et al.*, 1987) [7]. It is not always that where the butterflies can be seen that will be the exact place where they can be seen to roost as well. A particular area might be feasible for them to collect food resources but not for them to roost. Thus, mostly they were found less in the same area while roosting or after dark. This is due to the availability of vegetation. It is essential to keep an eye on the vegetation available and also what kind of vegetation is required for them to choose the same area for roosting as well (Blozan, 2006) [17].
From this preliminary study of roosting behaviour among butterflies, it was inevitable that roosting in butterflies was also affected by different factors similar to other animals (*e.g.*, Trivedi and Johnsingh, 1996) [30]. Suitable habitats with better surroundings would influence the flourishing of the population and abundance of roosting butterflies (Salcedo, 2010) [4]. The activity of the butterflies was relatively higher as seen during the daylight hours. While roosting they were hard to sight or find because of the intensive darkness as well as the camouflage of butterflies when they roost (Kalaiselvan and Ramesh, 2014) [31]. Even after all this, with limited resources, it was possible to see quite a few species and prolonged studies will reveal more of them. In the case of communal roosting, a plausible explanation of this kind of behaviour among themselves could be to keep themselves warm in the winter season and to keep potential predators away from them (Finkbeiner *et al.*, 2012) [28]. As gregarious roosting (Finkbeiner, 2014) [8] was not seen at all except for one occurrence, further research is needed to confirm the exact reason for this behaviour.

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Author's contribution statement
PA and RN conceived and ABR supervised the study. PA and AR conducted the data collection and the data analysis was done by PA and RN. PA, RN and AR contributed to the writing. AR formatted and prepared the final draft. All authors approved the final version of the manuscript.

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