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Comparison Of Butterfly Diversity In Natural, Semi-Natural And Human-Modified Ecosystems At Kundamankadavu,Thiruvananthapuaram, Kerala, South India .

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Abstract

Among insects, butterflies are the most taxonomically studied group and play key role in ecosystem as pollinators and bioindicator species. The diversity of butterflies inhabiting at Kundamankadavu, Vilavoorkal Panchayath, Thiruvananthapuram was recorded through a Pollard walk method by traversing slowly and observing within 5m radius of the observer for the period of November 2019 to March 2020. Three different ecosystems such as natural, semi-natural and human-modified ecosystems were evaluated for analysis of the diversities of butterfly species. The maximum diversity was observed in the natural ecosystem. A total of 15 species were observed across the three habitat types during the study period. Maximum number of butterflies were observed in natural ecosystem (6) followed by human-modified (5) and minimum in semi-natural ecosystem (4) respectively. Out of these, members belonging to the family Nymphalidae was the most common with 6 species being recorded accounting for 34% of total species. The study area is rich in butterfly diversity and further research could be conducted to obtain more details and documentation on butterfly diversity for the conservation and butterfly park. As the population of these insects decline rapidly due to human activities, habitat destruction, uses of pesticides and unawareness of people about the importance of butterflies, appropriate measures should be adopted for their protection.

Keywords: Bioindicator, Pollard walk, human- modified ecosystem, butterfly diversity.

1. INTRODUCTION

It is well known that biodiversity is rapidly disappearing at local and global scales and that this is in great part attributable to human activities such as deforestation and intensification of land use, which have resulted

in land degradation [1]. In many industrialized countries, extensive areas of the landscape have become more homogeneous in structure, resulting in a reduction in biodiversity levels, owing to their conversion to agriculture and grasslands with high inputs of fertilizers and pesticides [2]. This conversion and intensification of land use, among other anthropogenic pressures, pushes species to shift from their present locations, tracking suitable habitats [3]. Species shifts may disrupt community composition and destabilize ecosystem functioning and services such as pollination of crops and wild plants [4].

Butterflies are a taxonomically well studied group, which have received a reasonable amount of attention throughout the world. They are good indicators in terms of anthropogenic disturbances and habitat quality . Butterflies being exothermal are highly sensitive to climatic variation and a short generation time which makes them appropriate model organisms to study. Butterflies are sensitive to climate change, such as pollution and habitat loss cause them to be more responsive. Therefore, an abundance of butterflies usually indicates a healthier ecosystem. As a wildlife indicator, butterflies tell us almost everything we need to know about the health of an ecosystem [5].

Human dominated landscape form a substantial and ever-increasing amount of the earth's land surface. These modified habitats often negatively influence butterfly species and their dynamics. The change in land use pattern may lead to landscape changes that can reflect into change in butterfly diversity and distribution. As a result, butterflies can also be used as umbrella species (the species whose protection serves to protect many co-occurring species) for conservation planning and management [6]. Butterflies that are well adapted to the landscape and react quickly to any alteration in their habitat as a result of human-induced activities such as farmland intensification and intensive logging [7]. Information on species composition, diversity, preferred host plants, food plants and distribution pattern of butterflies requires periodic updating in protected areas as many butterfly species are facing threat in natural ecosystems including protected areas.

Butterfly diversity of different habitats at Indian institute of Forest management, Madhya Pradesh was studied by Harsh, 2014[8]. He found that diversity was higher in open scrub areas compared to semi-urbanized regions. In studies conducted in Netherlands, butterflies showed different functional and species diversity in relation to vegetation structure and land use. Study found that functional diversity and species diversity of butterflies are not consistently correlated and must therefore be treated separately [9].

Butterfly species composition and diversity in protected areas of Karnataka, India was investigated by Basavarajappa *et al.,* 2018[10].The study reiterated the need for conserving forest ranges as the species diversity was found to be high across the ranges studied. The diversity of butterflies along with the contrasting six selected land-use types and three major seasons in Delhi for the years 2015–16 and 2016–17 was also investigated [11].The findings of this study indicated the significance of green patches within urban infrastructure in the cities to support a wide array of butterflies.

The short duration of the study precluded a complete documentation of the butterfly fauna of the area, and hence the list of species reported in this study is not a comprehensive checklist. A detailed study covering all the seasons would be required for a comprehensive checklist. Prevalence of unfavourable weather conditions often affect habitat suitability leading to local extinction of butterflies. Unfortunately developmental activities and resulting habitat fragmentation create threats to the survival of butterflies worldwide. The present study mainly concentrates on butterfly diversity, habitat preference like natural, semi-natural and human- modified ecosystems in Kundamankadavu, Thiruvananthapuram district of Kerala State.

2. MATERIALS AND METHODS

2.1 Study area

The study was conducted at Kundamankadavu which comes under Vilavoorkal Panchayath in Thiruvananthapuram district as the data collecting site. The study had mainly focused on comparing the species diversity of butterflies in three different ecosystems-a natural,vsemi-natural and a human-modified ecosystem(Fig. 1-3).The natural ecosystems are purely natural and their formations are not in any way influenced by human activity. Hence Kundamankadavu riverside was selected for study. Semi-natural ecosystem had retained most of original flora and fauna. Banana plantation was selected as the human-modified ecosystem with humans determining the species composition of the ecosystem.

Fig. 1 Natural Ecosystem

Fig. 2 Semi -Natural Ecosystem

Fig. 3 Human-modified Ecosystem

2.2 Methodology

The Pollard walk method was adopted [12,13,14] to determine the variety of butterflies in the three ecosystems selected. Sampling was carried out at selected habitats from November 2019 to June 2020.The butterflies were observed by traversing slowly (15 minute per transect)and observing within 5m radius of the observer[15].The transect route was selected in such a way that it was a fair representation of the habitat and was divided into five sections. The species were recorded around the observer covering either side, above and front. Observations of butterflies were made once a week from 9.00h to 12.00h and 14.00h to 17.00h[13; 16] during good weather period (no heavy rain or strong winds).The nomenclature used in the checklist of Butterflies in IUCN (2015) was followed. Typical and unique features of the wings, abdomen and pattern of colouration of all body parts were noted down.

2.3 Collection and Preservation

The study mainly focused on the diversity and comparison of butterflies in these three ecosystems. The butterflies were photographed using mobile phone camera having appropriate megapixels. They were caught with a butterfly net and are then preserved.
The preservation of butterflies included the following steps:
(1)Netting and killing the butterfly:-
After netting a butterfly using an aerial net, they were killed using a poison box. Poison box is a box containing chloroform dipped cotton which kills the butterfly.
(2)Relaxing the dead butterfly:-
After killing the butterflies using the chloroform, the specimen was relaxed. Otherwise, they become extremely brittle. After relaxation, they were mounted in desirable position. Relaxing chamber is simply a plastic container with a piece of folded paper towel moistened with water at the bottom. The butterfly is carefully placed within the chamber, closed the chamber and is refrigerated for about three days.
(3)Pinning the butterfly:-
After 3 days, the butterfly was taken out from the relaxing chamber. It was then placed over a Styrofoam using forceps and its wings are carefully spread over it using a needle. Then its wings were covered by wax paper or tracing paper and pinned using stainless needles without touching its body.
(4)Drying the pinned specimen:-
The pinned butterfly was kept in a cool dry safe place for almost 2 weeks. Naphthalene balls were used to prevent the other pests or insects attacks.
(5)Display of butterfly:-
After about 2 weeks, the pins and papers were removed from butterfly. Lifted the butterfly carefully and placed on an insect box after piercing a stainless, thin insect needle through the thorax of the butterfly.
All the characters were noted. All the specimens collected were identified in the field using standard guides [17] and with the help of internet sources as soon as possible.

3. RESULTS

A total of 15 butterflies species belonging to 5 different families of order *Lepidoptera* were recorded in the study area. Among these, 6 species were identified from natural ecosystem (3 families), 5 species from human-modified ecosystem (4 families) and 4 species (3 families) from semi-natural ecosystem. Species belonging to Lycaenidae was found only in human-modified ecosystem whereas Nymphalidae family had a representation in all the three ecosystems. Nymphalidae was the richest family in the study area that comprised 5 species of butterfly followed by Pieridae and Papilionidae (3 species each). A similar pattern of predominance of Nymphalidae was also reported by different researchers [13,15] from Western Ghats. Hesperiidae and Lycaenidae families were lowest with 2 species.
The checklist of the species of butterfly observed in the study area is presented in (Table 3.1, 3.2and 3.3)
The list of identified specimens and description of each species with identifying features are given below.

TABLE 3.1 BUTTERFLIES COLLECTED FROM THE NATURAL ECOSYSTEM

Family	Common name	Scientific name
Pieridae	1)Common grass yellow	*Eurema hecabe*
	2)Cabbage white	*Leptosia nina*
Nymphalidae	3)Common bush brown	*Mycalesis persues*
	4)Glassy tiger	*Parantica aglea*
	5)Common four-ring	*Ypthima huebneri*
Hesperiidae	6)Grass demon	*Udaspes folus*

(1)*Eurema hecabe* (Common Grass Yellow)

E.hecabe, the common grass yellow is a small Pierid butterfly species found in Asia, Africa and Australia. They are found flying close to the ground and are found in open grass and scrub habitats. It is simply known as "the grass yellow "in parts of its range; the general term otherwise refers to the entire genus Eurema.
Features: 40-50mm.Yellow with variable dark brown markings and variable fine black dusting on underside. Hind wing margin angulated at vein 3.Underside of the forewing(UNF) with 2 cell spots, but one or both may be absent. One irregular ring spot end-cell. Apical area may have a dark brown patch but not significantly large. Upper side of the forewing (UPF) apex and termen broadly black with 2 excavations in space 2 and 3.Terminal black border almost right angled at vein 4 and partly extending towards base along dorsum. Upper side of the hindwing(UPH) with narrow diffuse black border.
The Common grass yellow exhibits seasonal polyphenism. The lepidopteran has a darker summer morph, triggered by a long day exceeding 13 hours in duration, while the shorter diurnal period of 12 hours or less induces a fairer morph in the post-monsoon period.

(2)*Leptosia nina* (Cabbage White)

Features: 35-50mm.Rounded wings. Upper side white with UPF black apex and a large black post-discal spot.UPH unmarked.UNH white with fine greenish or brown striations. Fine black marginal dots at the end of veins. Dry season form with less striate.

(3)*Mycalesis perseus* (Common Bushbrown)

Features: 35-55mm.A white straight discal line on underside of both wings with prominent sub-marginal ocelli in wet season form. Ocelli reduced in spots and discal line obscure in dry season form. Intermediate seasonal forms common.UNH ocellus in space 3 shifted out of line towards termen[Hence hind wing lower 4 spots aligned in 2 groups, spot 2 and 3 out of line with the lower 2 in space 1b].UNF a curved series of ocelli in spaces 2-5 in wet season form[variable]. UPF small ocellus only in space 2[may be absent in wet season form].UPH an ocellus in space 2[not ringed].Both wings with double, pale sub marginal line. Male:

UPH sexual band at the base of vein 7 black, covered with yellowish white hair pencil.UNF broad along vein 1b small, oval and black. Both brands are set in a smooth pearly area. Sex brands are not visible on field.

(4)*Parantica aglea* (Glassy tiger)

Features: 70-85mm. Ground colour dull black with numerous transparent bluish-white spots and streaks. Forewing: Vein 11 anastomosed with vein 12.Pale long streak in forewing cell, divided by two thin dark lines. Basal spots streaks like, discal spots quadrate and rows of oval sub-marginal spots. UNF cell with two long white streaks. UNF discal elongated streaks beyond cell almost reaching sub-marginal area.UNH upper and lower white streaks in cell fused at either end. Underside similar, the markings blurred. Head and thorax black spotted with white, abdomen brown above, yellowish beneath. Male: Hind wing has two scent pouches close together [larger on vein 2 and smaller on vein 1].Two abdominal hair pencils.

(5)*Ypthima huebneri* (Common Four-ring)

Features: 30-35mm.Greyish brown underside with small, very fine dark striations and yellow ringed black ocelli.UNH three tornal ocelli [in space 1, 2 and 3] and one apical ocellus in space 6, not on a dark band.UNF large sub-apical ocellus.UPF large sub-apical ocellus.UPH at least two ocelli [in space 2 and 3], no white [except small patch of white tornal scales in dry season form].Male with no band. Female larger and paler. Wet season form with ocelli large and prominent, dry season form with ocelli reduced.

(5)*Udaspes folus* (Grass Demon)

Features: 40-45mm.Brown to reddish brown upperside.UPF a spot across cell, a bent spot in space 1b-2, small detached spot in space 3, conjoined spots in space 4 and 5, conjoined sub apical spots in space 6 to 8.UPH a large central white patch in space 1c to 6.UNH brown with a large, irregular white patch from wing base to sub-marginal area and a variable central sub costal spot.UNF spots as on UPF. Seasonal variation

TABLE3.2 BUTTERFLIES COLLECTED FROM THE SEMI-NATURAL ECOSYSTEM

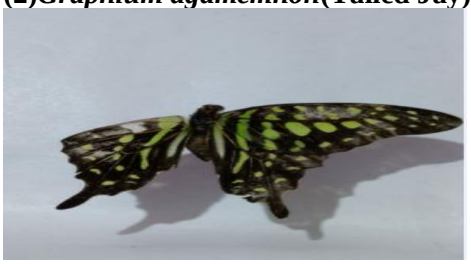
Family	**Common name**	**Scientific name**
Hesperiidae	1)Giant red-eye	*Gangara thyrsis*
Papilionidae	2)Tailed jay	*Graphium agamemnon*
	3)Common mormon	*Papilio polytes*

Nymphalidae	4)Common evening brown	*Melanitis leda*

(1)*Gangara thyrsis*(Giant Red Eye)

Features: 70-76mm.Large wine red eyes. Has a very long proboscis. Male and female dark chocolate-brown. **Male:** Upper side dark brown with large, quadrate, semitransparent yellow spots on forewing across cell, in space 2 and 3.Three sub-apical spots in space 6 to 8.The middle part of vein 1b and basal part of vein 2 swollen. Underside dusted with grey scaling at apex. Forewing and the scaling on UNH forms few indistinct bands. Underside with a thick patch of yellow, specialized scales along vein 1b of forewing. **Female:** Larger and no secondary sexual characters.

(2)*Graphium agamemnon*(Tailed Jay)



The tailed jay is a predominantly green and black tropical butterfly that belongs to the swallowtail family. The butterfly is also called the green-spotted triangle, tailed green jay, or green triangle.
Features: 85-100mm.Forewing apex produced and the outer margin is slightly serrated. Hind wing with a long tail [longer in female than male]at vein 4.Upperside black with basal green stripes and green spots.UPF cell spots double. Underside darker with dark green basal and discal spots while marginal spots paler. UNH pale sub costal spot bearing a black spot with a red lunule. Male with tufts of long scent scales in the anal fold. Sexes similar.

(3)*Papilio polytes*(Common Mormon)

Features: 90-100mm.Black body and wings. Hind wing tailed at vein 4.Male:Forewing marginal row of white spots decreasing in size towards apex. Hind wing with a row of elongated discal white spots and sub-marginal red lunules[may be faint].Female with three forms. Extent of red and white markings variable and aberrations known. Female form *cyrus*: resembles the male but has a red tornal spot in space 1a of the hind wing. Red marginal crescents prominent. Tail longer. Female form *Romulus*: Mimics Crimson Rose.UPF broad, large, irregular central and apical bands formed of elongated white streaks.UPH elongated red discal spots, sub-marginal and marginal red crescents. No red on body. Female form *stichius*: Mimics common rose.UPF with

prominent black streaks between veins.UPH with elongated white discal spots in spaces 2 to 5[which may enter cell],a series of red sub-marginal and marginal lunules. No red on body.

(4)*Melanitis leda* (Common Evening Brown)

A common species of butterfly found flying at dusk. The flight of this species is erratic. Resident butterflies are known to be very territorial. They have been known to fight off visitors to an area at dusk. This chase behaviour is elicited even by pebbles thrown.

Features: 60-80mm.Hindwing soothed at vein 1 and vein 3.Upperside brown.UPF large black sub-apical ocellus bearing two white spots in space 3 and 4 and an orange band on inner and upper side , not reaching the costa. A black diffuse sub-apical patch above the ocellus.UPH sub-marginal ocelli or white spots. Sexes similar but ocelli UPH prominent in females.

TABLE 3.3 BUTTERFLIES COLLECTED FROM THE HUMAN-MODIFIED ECOSYSTEM

Family	**Common name**	**Scientific name**
Lycaenidae	1)Common ciliate blue	*Anthene lycaenina*
	2)Red pierrot	*Talicada nyseus*
Pieridae	3)Common emigrant	*Catopsilia pomona*
Nymphalidae	4)plain tiger	*Danaus chrysippus*
Papilionodae	5)Common rose	*Pachliopta aristolochiae*

(1)*Anthene lycaenina*(Pointed Ciliate Blue)

Features: 24-29mm.Hindwings tailless but with short, small, white tufts. Forewing pointed. In both sexes however, but especially in the male, the forewing is distinctly narrower and more acute at apex and the hind wing more acutely angulated at the tornus. In the markings on the upper side the two forms are closely alike; on the underside they differ as follows: Ground colour similar but a shade darker.

(2)*Talicada nyseus* (Red Pierrot)

Features: 30-36mm.Hindwing tailed. Sexes similar.UNF white with large broad black band beyond disc bearing white spots. Black spot end cell.UNH white with broad orange marginal band [black at apex]bearing white spots. Black basal and discal spots. Cilia chequered. Upper side black with a broad orange area hind

wing.[Above orange area more extensive and UNH markings reduced, most of discal band absent as compared to other Indian subspecies].Wings semitransparent.

(3)*Catopsilia pomona*(Common Emigrant)

Catopsilia Pomona, the common emigrant or lemon emigrant, is a medium-sized pierid butterfly found in Asia, Campodia and parts of Australia. The species gets its name from its habit of migration.
Features: 55-75mm.Variable species with multiple forms of both sexes. Upper side greenish white or yellow with UPF variable black border along the costa and termen. There are two groups of the forms, Crocale group and Pomona group. All forms fly together.

(4)*Danaus chrysippus*(Plain Tiger)

Features: 70-80mm.**Form chrysippus:** UPF orange yellow with broad black apical area bearing a broad white post-discal band and few white spots.UPH orange with a narrow black border bearing small white dots. Black spots around end-cell. Veins not black.UNH pale yellowish-orange with black spots.UNF reddish brown with orange apex and white sub apical band and spots. **Form alcippoides:** Very large white patch on hind wing both sides. Veins not black. This form is rare in Western Ghats and found in drier regions. **Form dorippus:** UPF black apex with white markings absent. This form is uncommon. **Male:** scent scale pouch hind wing[as a black patch with white center UNH].Two abdominal hair pencils.

(5)*Pachliopta aristolochiae*(Common Rose)

Features:80-110mm.**Body red** with black markings. Hind wing tailed. **Upper side** black with pale outer half forewing.UPF black streaks between veins.UPH five[few may be absent]white elongated discal spots in spaces 2 to 5.Discal spots remote from cell and incomplete. Rarely a small white spot end-cell. A sub-marginal series of dirty-red crescents. **Underside** black with UNH a series of red or pink sub-marginal spots and white discal spots but discal spot in space 1 is red. Sexes similar. Male with narrow forewing.[A variation ***diphilus*** is mentioned by Evans with discal spots complete and against cell].
The results showed that, Nymphalidae was the richest family in the study area that comprised (34%) species of butterfly followed by Pieridae and Papilionidae families with (20%) species each and Hesperiidae and Lycaenidae families were the lowest with (13%) species each as indicated in (Figure 5.1).

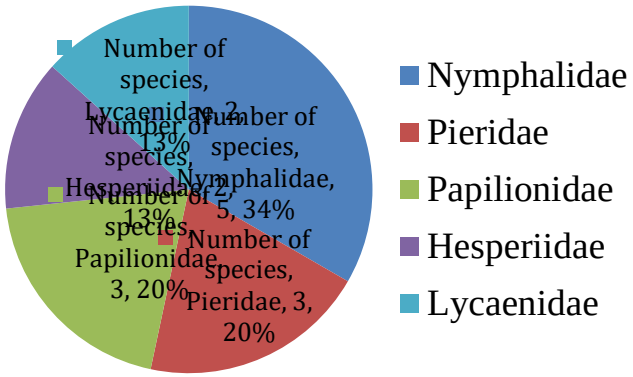


Figure 4: Family wise percentage composition of the species of butterfly in the study area

4. DISCUSSION

Butterflies are one of the most conspicuous species of Earth's biodiversity. Being extremely responsive to any changes in their environment, namely temperature, humidity, light, and rainfall patterns these insects are identified as useful bioindicators[18].Butterflies, like other invertebrates, carry out important ecosystem services and functions (e.g., acting as pollinators and environmental quality indicators) around the world and in natural and managed ecosystems [19]. The present study aims to examine the diversity and distribution of butterflies across three different habitats.

In the present study, a total of 15 species of butterfly representing five families were recorded during the study period from the three selected study sites. Out of the three study sites, site-1,natural ecosystem supported maximum numbers of butterflies (6 species) and site-2, semi-natural ecosystem contain 4 species only that is; species richness was found to be higher in natural ecosystem, compared to semi-natural one.

A banana plantation was selected as the human-modified ecosystem for the study which also accounted only less number of butterfly species than the natural ecosystem. Studies conducted on human-modified ecosystems of Sikkim, produced similar results [20].

Based on family wise composition of checklist of the species of butterfly observed in the study area, Nymphalidae family was the highest number of the species of butterfly among the other families which may be due to adaptation and habitat preference of the species. Similar studies reported by Singh and Chib, 2014[21] on a preliminary checklist of butterflies that recorded 125 species of butterfly from 78 genera belong to 5 families. The family, Nymphalidae had a representation in all the three ecosystems. Species belonging to Pieridae family was found in both natural and human-modified ecosystem whereas those belonging to Lycaenidae were only confined to human-modified habitat. Semi-natural and human-modified ecosystems had the species of Papilionidae family which was absent in the natural site. The conservation status of most butterflies that are studied is Common. However, the rest of the total butterflies are considered to be of Not Evaluated (NE) for their conservation status according to IUCN except that of *Talicada nyseus*. The Red Pierrot of the family, Lycaenidae belongs to the Least Concern (LC) category. In the study area, none of the butterfly species are found to be globally threatened.

Nymphalidae family has the highest number of species (34%) followed by Pieridae and papilionidae (20%) each and the lowest number of species were found in the families, Hesperiidae and Lycaenidae (13%) each. The result of this study conceded with the findings of Sayeswara,2018[22] who was recorded higher percentage of the species of butterfly from Nymphalidae family with 44.4%, followed by Papilionidae of 22.2%, Lycaenidae having 8.33% and Hesperiidae was the least percentage of the species of butterfly in the study area. This finding agrees with that of Koneri and Nangoy,2019[23]who observed the status of Sangihe Island butterflies and recorded maximum number of the species of butterfly from Nymphalidae family constituted with 53.81%, followed by Papilionidae of 22.67%, Pieridae with 15.57%, Lycaenidae having 7.31% and Hesperiidae with only 0.64% in the study area. Nymphalidae family indicated as dominant during the study period with the highest number of the species of butterfly. In addition, the result is supported by Bubesh *et al.,* 2012[24] who observed 50 species of butterfly belong to 5 families. Arun and Azeez ,2002 [25] also recorded that Nymphalidae is the most abundant and species rich family in Puyankutty forest, a total of 257 butterflies belonging to 17 species were observed during the survey.

The structural complexity of habitat and diversity of vegetation forms have been shown to be correlated with animal and insect species diversity [26].Further, the results are in strong agreement with Sethy *et al.,* 2014

[27] who also reported that Nymphalidae represent the dominant family in the study area with 42.5% followed by papilionidae of 21.2%, Lycaenidae 15.1%, Pieridae 14.1% and Hesperiidae with 7.1%. The vegetation and habitat types in the study area might be reason for the above common occurrences of the species of butterfly. Each and every site had various habitats pattern. Some types of butterflies have great flying distances to find a host. Host plants are where the larvae obtain their food from the larval stage to the imago [28]. Butterflies have a special food source that is often endemic in an area. This is due to the nature of the host plant, which is usually endemic in an area. Some species of butterflies have specific host plant needs as a place to lay eggs and as larval feed. Butterflies inhabit different vegetation and feed on different sources at different life stages [29]. Host plants are utilized only when sufficient adult resources (nectar) are also available [30]. Successful butterfly habitat must therefore include sufficient larval and adult food resources. In the present study, the maximum numbers of species were observed in the natural habitat where availability of diverse plants and access to host plants promoted the butterfly richness. Comparatively the other habitats, semi-natural and human-modified have lesser density of vegetation and hence lesser number of species. These habitats being highly disturbed due to anthropogenic activities could also account for lower butterfly colonization.

It is a wrong notion that all butterflies love nectar in flowers. There are many species of butterflies (many belong to the brush-footed and brown butterflies) which never visit flowers. These flies like to get their stock of food from rotten fruits, decaying fish, crabs or prawns, the scat or dung or urine of wild animals and so on. The Common Evening Brown, *Melanitis leda*, is one of the butterflies that are attracted to these materials. Sunshine is very important in the life of butterflies as they are cold blooded animals and need to bask in sunlight before they start their activities in their morning.

The environmental conditions in Kundamankadavu are highly favourable for butterflies to complete its life cycle. Even though Kundamankadavuis a semi urban area, presence of different types of butterflies calls for greater conservation strategies like creating butterfly parks, gardens and by preserving the existing vegetation as such. By conserving butterflies, we are indirectly maintaining the ecological balance.

The present study reveals that the study areas provide favourable ecological conditions and habitat for butterflies. It might be due to the presence of sufficient host plants and favourable climatic conditions for the development and growth of butterflies. The host plants and the related butterfly species often are known to share some biochemical features. Butterfly diversity indirectly reflects an overall diversity of plants, especially herbs and shrubs in a given area [31]. Although, study areas support a good number of butterfly species but much has still to be explored. From our observation we conclude that, even in the small study area butterfly communities varied significantly among different habitats.

5. CONCLUSION

The present study revealed the existence of good diversity of butterflies in the selected study sites. In general both the study sites were more or less similar in butterfly diversity. However, natural ecosystem was found to be rich in diversity as compared to other. From this survey, it showed that the number of species of butterflies observed in natural ecosystem was consistently greater than semi-natural and human-modified ecosystems. That is natural ecosystem was found highest among the other sites in terms of number of species of butterflies. Butterflies maintain the ecosystem by acting as pollinator, prey, biological pest control, induce genetic variation in plants, and enhance environmental beauty, reduce the level of carbon dioxide in air. But butterfly population is decline rapidly and it is suggest that greater emphasis should be placed on management of habitat and better integration of protected areas. Ecologists use butterflies as model organisms to study the impact of climatic change, habitat loss.

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