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Butterfly-Plant Diversity in Malappuram District Of Kerala, India: A Way of Plant – Pollinator Communications

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Abstract- The present study documented that, total of 33 plant species belonging to 18 families and 29 genera were pollinated by various kinds of butterflies (41 butterfly species belongs to 27 genera and 5 families) Among the documented plant familiesAsteraceae is the dominant one with 10 species, followed by Fabaceae with 4 species and Boraginaceae and Verbenaceae with 2 species respectively. The plants which are documented from the study are divided in to two categories such as plants are pollinated by various butterflies (33 species) as well as plants are preferred by different butterflies for their ovi posting and larval development (63 species). The flower colour analysis reveals that maximum number of butterflies which are visited yellow colour (10 species) followed by white colour (8 species), orange colour (7 species), red colour (6 species), violet (3 species), yellowish-orange (2 species), purple (2 species). Cream, rose and blue colour visited by single butterfly species respectively. Present study also concluded that, the plant-insect interaction is an essential factor for pollination process and better yield in both wild as well as crop plants. Hence an adequate care should be taken to conserve both flora and fauna of our surroundings for future generation.

Keywords- Butterfly-plant interaction, Pollinators, Ovi posting, Conservation

I.INTRODUCTION

A significant majority of insects have strong interactions with plants and other biotic components of any ecosystem[1]. Organisms that visit flowers for nectar or pollen may or may not pollinate the plant species [2]. Butterflies are takes part in the key stone ecological process of pollination[3]. The interaction between butterflies and flowers is indeed so strong that the availability of nectar resources invariably appears as one of the main factors explaining the butterfly abundance in semi-natural or natural habitats [4,5].

Butterflies enable sustenance of ecosystem services through their role in pollination and serving as important food chain components[6]. Over the entire period of their active life, the butterflies engage in a spectrum of plant-feeding relationships which are often very complex involving co-evolution and obligate mutualism; such interaction can be a major factor in generating patterns of diversity in both the partners [7,8]. Flower-visiting insects play an important role in maintaining biodiversity and ecosystem services such as pollination, which corresponds to a great economic value [9]. Many studies have shown that insect abundances are highly correlated with the abundance of floral nectar sources [10,11]. Butterflies and flowers are in close relation with regard to pollen dispersal for plant propagation; On the other hand Butterflies get proteinacious substances for successful reproduction[12].Majority of insects, especially butterflies has strong ecological relationships with the flowering plants which are available in particular habitats[13,14,15,16]. Mutualistic interactions such as plant–pollinator interactions at a communitylevel are known to provide this structure and stability to biotic communities[17,18].It is very common in nature for interspecific interactions tooccur as complex interaction networks, where a particular flower visitor may visit severalplant species, but with a variable efficiency ranging from nectar robbers to potential pollinators [19,20,21]. Butterfly speciescould also interact with their feeding plants in such a manner those interactions couldbe represented as complex networks. The present study is mainly aims to document the plants which are pollinated by butterflies and also document the butterfly diversity in present study area, it also analyze various threatening factors of the study area and make to the awareness about the role of butterflies in pollination in both wild as well as crop plants among natives.

II.STUDY AREA

Malappuram district is bounded by the Nilgiris hills on the East and the Arabian Sea on the west, Kozhikode and Wayanad Districts in the north and Palakkad and Thrissur District in the south.The district of Malappuram literally the land with hills, is remarkable for its unique natural beauty.

Perched among the undulating hills and the meandering rivers that flow to reach the coconut-fringed seacoast, the land conceals a unique and eventful history (**Fig. 1**).

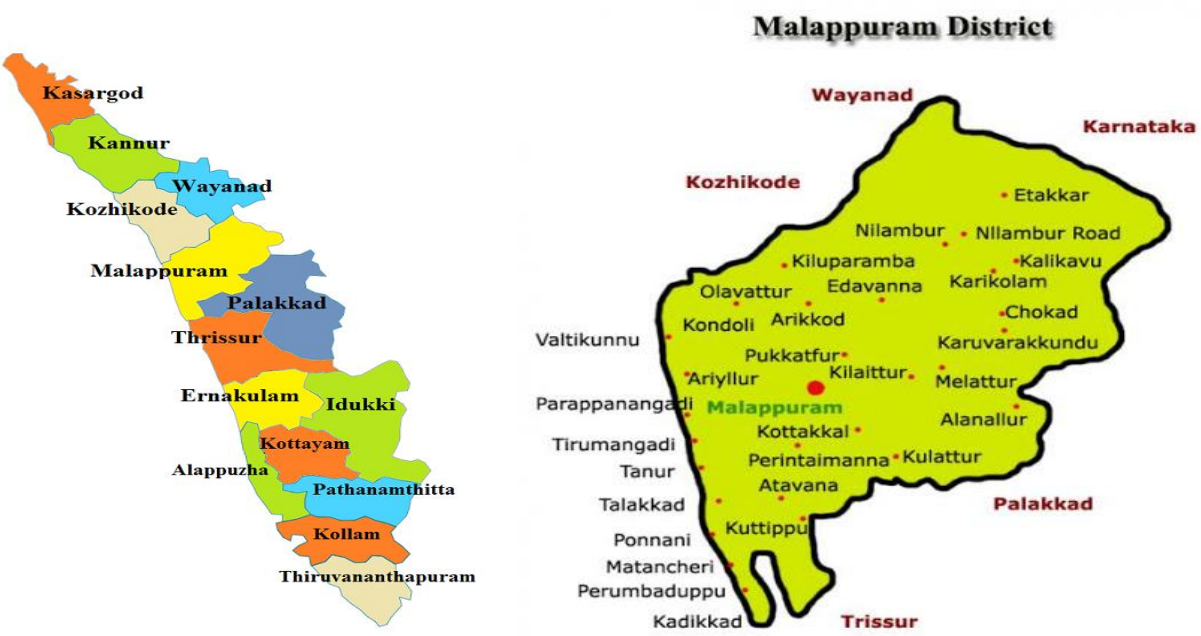


Fig.1 Map of Kerala state and Malappuram District

The district has a geographical area of 3550 sq. Kms, which is 9.13% of total area of the state and ranks 3rd in the state. The district has dry season from December to February, hot season from March to May and the South west monsoon from October to November. The South west monsoon is usually very heavy and nearly 75 percent of the annual rains are received during this season. The climate is generally hot and humid; the range of temperature varying between 30 ^{0}C and 20 ^{0}C. The average annual rainfall is 290 mm. Malappuram consist of 3 natural divisions, lowland, midland and highland. The low land stretches along the sea coast, the midland in the centre and the highland region towards the East and North eastern parts. The topography of the district is highly undulating; starting from the hill tops covered with thick forest on the East along the Nilgiris, it gradually slopes down to the valleys and the small hills, before finally ending on the sandy flat of luxuriant coconut groves in the west. The hill country also contributed much to the cultural artistic traditions of the state[22].

Four important rivers of Kerala flow through Malappuram district. They are Chaliyar, Kadalundippuzha, Bharathapuzha and Tirurpuzha.The district has a total forest area of 758.8684 Square Km,out of which 325.3261 Square Km is reserve forests and 433.5423 Square Km is vested forests. Of the forests 80 percent is deciduous and the rest is evergreen. Forests are the main source of raw materials for a number of wood-based industrial units. Besides timber, firewood and green manure, forest produces like honey, medicinal herbs, spices etc are collected. The tribalsalso collect minor forest products. The forests are protected by two forest divisions-Nilambur north and Nilambur South. The social forestry division promotes planting of trees outside forestlands, for protecting natural forests.

III. MATERIALS AND METHODS

The present study was based on an extensive field observation during the year November 2019-February 2020. In this study an attempts were made to document the interaction between Plants and Butterflies at Malappuram district. The documentation was mainly based on the field observation, photographs as well as scrutinizing the literature review. During the field visits, observations are made based on butterflies that interact with different plants and photographs are taken (**Plate-1&Plate-2**).The collected photographs of plants and butterflies were identified taxonomically with the help of available literature and online sources. Mainly the identification of butterflies was done with the help of the photo field guide of *The Butterflies of Kerala* [23]. *Butterflies of Peninsular India* [24]. (KrushnameghKunte, 2000) & *Butterflies of Western Ghats* [25].Plants were identified with help of existing Floras and Literature [26,27,28].The nomenclature of each species has been brought up to data as per the rules given in the International Code of Nomenclature (ICN). The plant specimens were processed for herbarium preparation [29] and it becomes stored in herbaria of Department of Botany, St. Joseph's College Devagiri (DEV) for future reference.

IV. RESULTS AND DISCUSSION

The present study on harmonization and interactions butterfly-plant diversity in malappuram district of Kerala noticed that, there are about 33 plant species which are

belonging to 18 families and 29 genera were pollinated by various kinds of butterflies (**Table-1**). Among these documented plant families, Asteraceae is the dominant one with 10 species, followed by Fabaceae with 4 species and Boraginaceae and Verbenaceae with 2 species respectively **(Fig.2).**

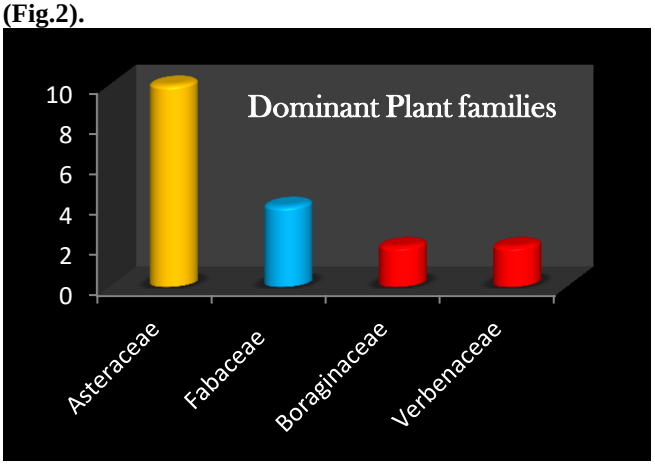


Fig.2 Analysis of dominant plant families in the study area

These plants are may be attracted by various butterflies either to its attractive flower or plant parts for insearch of nectar as well as pollens as a part of their nutrion. During such visits these butterflies may carries some amount pollen grains on their bodies and it may dusted on other individual of a same species which are located near by study area and there by cross pollination may oocur inbetween the individuals of same species. As the pollination occurs between flowers of two different plants, genetics recombination is found in this allogamy with the following advantages such as, It brings about genetic recombination resulting into the origin of new varieties, The offspring produced through cross-pollination are healthy and stronger due to hybrid vigour, Numerous crop plants gives higher yields if only cross-pollination is allowed to occur in them, Variations are produced due to cross-pollination resulting into the origin of disease resistant plants.

Table-1 Documentation plant species which are pollinated with different kinds of butterflies

SI No.	Name of a plant sps.	Family	Name of Butterfly
1.	*Tiliacoraacuminata*(Poir.) Miers	Menispermaceae	*Appias indica.*
2.	*Hibiscus rosa-sinensis* L.	Malvaceae	*Prioneris sita*
3.	*Oxalis corniculata* L.	Oxalidaceae	*Argynnis hyperbius.*
4.	*Murraya koenigii* (L.) Spreng.	Rutaceae	*Papilio polytes.*
5.	*Clitoria ternatea* L.	Fabaceae	*Hypolimna sbolina*
6.	*Crotalaria pallid* Dryand	Fabaceae	*Euploea core*
7.	*Crotalaria retusa* L.	Fabaceae	*Parantica aglea*
8.	*Crotalaria verrucosa* L.	Fabaceae	*Parantica aglea*
9.	*Caesalpiniapulcherrima* Swartz	Caesalpiniaceae	*Papilio anchisiades*
10.	*Calycopteris floribunda* Lam.	Combretaceae	*Castalius rosimon*
11.	*Psidiumguajava* L.	Myrtaceae	*Papiliolio medon*
12.	*Ixora coccinea* L.	Rubiaceae	*Papilio demoleus*
13.	*Pentas lanceolata* Defler.	Rubiaceae	*Hebomoia glaucippe*
14.	*Ageratum conyzoides* L.	Asteraceae	*Tirumala limniace*
15.	*Biden spilosa* L.	Asteraceae	*Tirumala limniace*
16.	*Bidens sulphurea* Sch.-Bip.	Asteraceae	*Elymnias hypermnestra*
17.	*Centratherum intermedium* Less.	Asteraceae	*Danaus chrysippus*
18.	*Crassocephalum crepidioides* Benth.	Asteraceae	*Tirumala septentrionis.*
19.	*Erigeron karvinskianus* DC.	Asteraceae	*Plabejus argyro gnomon*
20.	*Mikania micrantha* Kunth.	Asteraceae	*Parantica aglea*
21.	*Tagetes erecta* L.	Asteraceae	*Hypolimnas bolina*
22.	*Tithonia rotundifolia* Blake	Asteraceae	*Captopsilia pomona*
23.	*Tridax procumbens* L.	Asteraceae	*Hypolimnas misippus*
24.	*Heliotropium bracteatum* R.Br.	Boraginaceae	*Danaus genutia*
25.	*Heliotropium indicum* L.	Boraginaceae	*Danaus genutia*
26.	*Chrysothemis pulchella* Decne	Gesneriaceae	*Papilio budha*
27.	*Thunbergia grandiflora* Roxb.	Acanthaceae	*Eurema hecabe*
28.	*Lantana camara* L.	Verbenaceae	*Elymnias hypermnestra*
29.	*Stachytarpheta jamaicensis* Vahl.	Verbenaceae	*Danaus genutia*
30.	*Leucas aspera* (Willd.) Link.	Lamiaceae	*Tirumala septentrionis*
31.	*Alternanthera sessilis* (L.) R.Br. *ex*.	Amaranthaceae	*Castalius rosimon*
32.	*Pouzolzia zeylanica* (L.) Bennett	Urticaceae	*Pachliopta aristolochiae*
33.	*Spathoglottis plicata* Blume	Orchidaceae	*Elymnias hypermenstra*

Table-2 Documentation Butterfly and Host plant species in the study area

SI No.	Name of a plant sps.	Family	Name of Butterfly
1.	*Dioscorea oppositifolia* L.	Dioscoreaceae	*Tagiades litigiosa*
2.	*Ziziphus mauritiana* Lam.	Rhamnaceae	*Castalius rosimon*
3.	*Ziziphus rugosa* Lam.		
4.	*Ziziphus xylopyrus* (Retz.) Willd.	Rhamnaceae	*Discolampa ethion*
5.	*Butea monosperma* (Lam.) Taub.	Fabaceae	*Lampides boeticus*
6.	*Crotalaria pallida* Dryand.		
7.	*Pisum sativum* L.		
8.	*Trifolium repens* L.,	Fabaceae	*Plebejus argyrognomon*
9.	*Kalanchoe laciniata* (L.) DC.	Crassulaceae	*Talicada nyseus*
10.	*Viola pilosa* Blume	Violaceae	*Argynnis hyperbius*
11.	*Ficus religiosa* L.	Moraceae	*Cyrestis maenalis*
12.	*Asclepias curassavica* L.	Asclepiadaceae	*Danausc hrysippus*
13.	*Calotropis gigantea* (L.) R. Br.		
14.	*Ceropegia intermedia* Wight		*Danaus genutia*
15.	*Areca catechu* L.	Aracaceae	*Elymnias hypermnestra*
16.	*Arenga wightii* Griff.		
17.	*Cocos nucifera* L.		
18.	*Carissa carandas* L.	Apocynaceae	*Euploea core*
19.	*Nerium oleander* L.		
20.	*Streblus asper* Lour.		
21.	*Hemidesmus indicus* (L.) R. Br.	Asclepiadaceae	
22.	*Capparis moonii* Wight	Capparaceae	*Hypolimnas bolina*
23.	*Capparis sepiaria* L.		
24.	*Capparis zeylanica* L.		
25.	*Abutilon indicum* (L.) Sweet	Malvaceae	*Hypolimnas misippus*
26.	*Portula caoleracea* L.	Portulacaceae	
27.	*Phyla nodiflora* (L.) Greene	Verbenaceae	*Junonia almanac*
28.	*Barleria longiflora* L.	Acanthaceae	*Junonia atlites*
29.	*Justicia neesii* Ram.		
30.	*Cannabis sativa* L.	Cannabaceae	*Junonia lemonias*
31.	*Corchorus capsularis* L.	Tiliaceae	
32.	*Calotropisgigantea*(L.) R.Br.	Asclepiadaceae	*Parantica aglea*
33.	*Cryptolepis buchananii* Roem.	Periplocaceae	*Parthenos sylvia*
34.	*Tinospora cordifolia* (Willd.) Miers	Menispermaceae	
35.	*Tylophora indica* (Burm. f.) Merr.	Asclepiadaceae	*Tirumala limniace*
36.	*Clerodendrum infortunatum* L.	Verbenaceae	*Tirumala septentrionis*
37.	*Wattakaka volubilis* (L.f.) Stapf.	Asclepiadaceae	
38.	*Annona muricata* L.	Annoaceae	*Graphium agamemnon*
39.	*Annona reticulate* L.		
40.	*Annona squamosa* L.		
41.	*Cinnamomum camphora* (L.) Presl	Lauraceae	*Graphium sarpedon*
42.	*Persea macrantha* (Nees) Kost.		
43.	*Aristolochia bracteolate* Lam.	Aristolochiaceae	*Pachliopta aristochia*
44.	*Aristolochia indica* L.		
45.	*Citrus limon*(L.) Burm.f.	Rutaceae	*Papilio anchisiades*
46.	*Clerodendrum paniculatum* L.	Verbenaceae	*Papilio buddha*
47.	*Cinnamomum malabatrum* Burm.f.	Lauraceae	*Papilio clytia*

48.	*Polyalthia longifolia* Thw.	Annonaceae	*Papilio demoleus*
49.	*Artabotrys hexapetalus* Bhandar.	Annoaceae	*Papilio helenus*
50.	*Sida rhombifolia* L.	Malvaceae	*Papilio liomedon*
51.	*Mimusops elengi* L.	Sapotaceae	*Papilio polymnestor*
52.	*Clitoria ternatea* L.	Fabaceae	*Papilio polytes*
53.	*Centrosema molle* Benth.	Fabaceae	*Parnassius apollo*
54.	*Citrus limon* (L.) Burm.f.	Rutaceae	*Triodes helana*
55.	*Aristolochia indica* L.	Aristolochiaceae	*Troides minos*
56.	*Tiliacora acuminate* (Poir.) Miers	Menispermaceae	
57.	*Musax paradisiacal* L.	Musaceae	*Appias lyncida*
58.	*Albizia chinensis* (Osbeck) Merr.	Fabaceae	*Catopsilia pomona*
59.	*Senna alata* (L.) Roxb.	Caesalpiniaceae	*Eurema hecabe*
60.	*Senna tora* (L.) Roxb.		
61.	*Moullava spicata* (Dalz.) Nicolson	Fabaceae	*Hebomoia glaucippe*
62.	*Cassia fistula* L.	Caesalpiniaceae	*Pareronia valeria*
63.	*Mimosa diplotricha* C. Wight	Mimosaceae	*Prioneris sita*

There are about 41 butterfly species belongs to 27 genera and 5 families (**Table-2**). Among them *Euploea core* may prefer 4 host plants. The butterflies like *Graphium agamemnon, Hypolimnas bolina, Elymnias hypermnestra, Danaus chrysippus, Danaus genutia* and *Lampides boeticus* may have 3 host plants. The butterflies like *Eurema hecabe, Triodes minos, Pachlio ptaaristochia, Graphium sarpedon, Tirumala septentrionis, Parthenos sylvia, Junonia atlites, Hypolimnas missipus* and *Castalius rosimon* prefer 2 host plants. The other species prefer single plant species for their ovi posting and larval development.

Among 41 butterfly varieties, maximum number of butterflies which are visited yellow colour (10 species) followed by white colour (8 species), orange colour (7 species), red colour (6 species), violet (3 species), yellowish-orange (2 species), purple (2 species). Cream, rose and blue colour visited by single butterfly species respectively (**Fig. 3**).

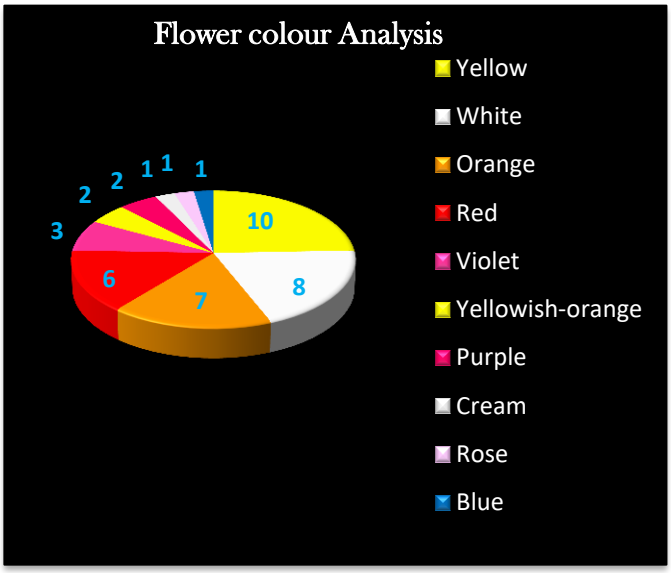


Fig.3 Analysis of various flower colourwith respect to the number of butterfly spcies

Some of the earlier studies reveal that, thefloral preference in pollinators may vary from species to species. Most of the species are highly generalized while a few of them are

highly specialized feeders[30].Studies onJothimani*et al*,[31]reveals that the colour of the flower is an important factor for plant-butterfly interaction. Among these 27-butterfly varieties, maximum number of butterfly visited on cream colour (14-varieties) followed by White colour (10-varieties) and Bluish-mauve (8-varieties). Orange-red, Whitish pink, Blackish brown, Bluish white, Green, Greenish yellow, Pale-yellow, Pinkish-purple and Purplish white visited by only one or two butterfly varieties only.

Similarly Leppik [32](1953) reported that the foragers should recognize the appearance of the flowers not just by their colours or by odour alone but by all essential characteristics of flowers such as size,colour, number of flower parts,symmetry and odour.The present study also observed that the butterflies are attracted to the flower initially based on their attractive colour.After that only they realized the presence or absence of nectar in their respective flowers. This was supports by some of the earlier workers [33, 34] alsofound that no relationship between size and visitation. A majority of studies have found that insect foragers exhibit higher rates of visitation to longer flowers [35,36,37,38,39,40,41].

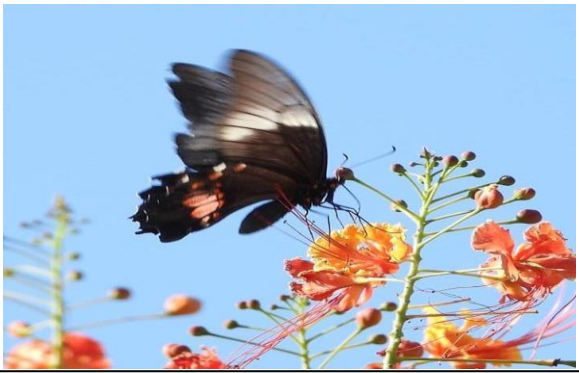
Flower size is correlated with production of pollen or nectar [42,43]. It has been shown that butterflies remember and associate certain stimuli like preferred taste of nectar with the shape and colour of the flowers and then choose flowers of similar features [44,45]. Butterflies have evidential capabilities to recognize the plant source of food.For the reason,it is important to note that each of the vegetation type can make unique contribution to the measured butterfly diversity and the butterflies for the plant diversity [46,47].

The present study mainly focalized on plant-insect interaction and how it affects pollen biology as well as pollination of various plants in the study area. Due to lack of suitable management, unsustainable utilization of natural resources, deforestation and urbanization, uncontrolled use of pesticides and in-organic manures, environmental pollution may adversely affect the existence of both insects and floral diversity of the area. It is concluded that, the plant-insect interaction is an essential factor for pollination process and better yield in both wild and crop plants. More over people should aware about the role of butterflies in pollination process of various plants in and around our habitats. Likewise different plant species are also used by these butterfly species for their ovi posting and larval development. So an adequate care should be taken to conserve both flora and fauna of our surroundings for future generation.

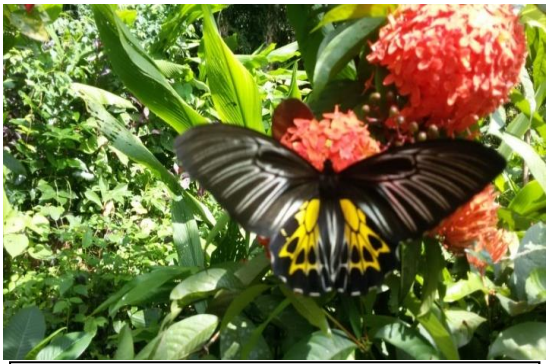
Plate -1

A.*Triodes helenacerberus* on ***Hibiscus rosa-sinensis*** L.

B. *Euploea core* on ***Crotalaria retusa*** L.

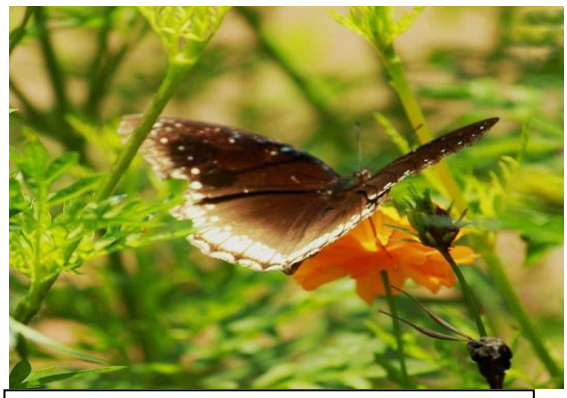


C. *Papilio anchisiades* on ***Caesalpinia pulcherrima*** (L.) SW.



D.*Triodes helana* on ***Ixora javanica*** (Blume) DC.

E. *Tirumala septentrionis* on ***Ageratum conyzoides*** L.



F. *Hypolimna sbolina* on ***Bidens sulphurea*** (Cav.) Sch.-

Plate -2

G. *Danaus chrysippus* on ***Centratherum intermedium*** Less.

H. *Danaus genutia* on ***Tagetes erecta*** L.

I. *Tirumala limniace* on ***Heliotropium indicum***L.

J. *Papilio Buddha* on ***Chrysothemis pulchella***

K. *Prionerissita* on ***Lantana camara*** L.

L. *Pachliopta aristolochiae* on ***Pouzolzia zeylania*** (L.) Bennett.

V. CONCLUSION

The present study on butterfly-plant diversity in Malappuram district of Kerala documented 33 plant species which are belonging to 18 families and 29 genera were pollinated by various kinds of butterflies. Among these documented Asteraceae is the dominant one with 10 species, followed by Fabaceae with 4 species and Boraginaceae and Verbenaceae with 2 species respectively. These plants are may be attracted by various butterflies either to its attractive flower or plant parts for insearch of nectar as well as pollens as a part of their nutrion. Similarly 41 butterfly species belongs to 27 genera and 5 families are also documented from the present study area. These butterfly species plays significant role in the pollination of many plants in the selected area.The plants which are documented from the study are divided in to two categories such as plants are pollinated by various butterflies (33 species) as well as plants are preferred by different butterflies for their ovi posting and larval development (63 species). The flower colour analysis reveals that maximum number of butterflies which are visited yellow colour (10 species) followed by white colour (8 species), orange colour (7 species), red colour (6 species), violet (3 species), yellowish-orange (2 species), purple (2 species). Cream, rose and blue colour visited by single butterfly species respectively. Due to lack of suitable management, unsustainable utilization of natural resources, deforestation and urbanization, uncontrolled use of pesticides and in-organic manures, environmental pollution may adversely affect the existence of both insects and floral diversity of the area. It is concluded that, the plant-insect interaction is an essential factor for pollination process and better yield in both wild as well as crop plants. Hence an adequate care should be taken to conserve both flora and fauna of our surroundings for future generation.

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