STUDY ON DIFFERENT NECTAR RICH FLOWERING PLANTS OF FEW BUTTERFLY SPECIES AT DIFFERENT HABITATS IN PJTSAU CAMPUS RAJENDRANAGAR, HYDERABAD, INDIA

ABSTRACT

The present study was conducted to investigate the different nectar rich flowering plants of few butterfly species at various habitats in PJTSAU campus, Rajendranagar, Hyderabad during the period from October 2022 to March 2023. The study was conducted in agricultural fields (college farm, student farm and Agricultural Research Institute (ARI)), open scrub areas, Agri biodiversity park (ABP) and botanical garden. To record the nectar plants of few butterfly species, systematic field survey through transact walk was conducted by employing visual count method (VCM) in various habitats. A total of 37 flowering plant species belongs to 20 families were visited by butterflies during the study period. Interestingly, flowering trees found to have contributed more (27.03%) followed by weeds (24.32%), cultivable crops (16.22%), herbs and shrubs with same contribution (13.51%) and the least contribution was found to have recorded with climbers (5.41%). Among the 20 families, Asteraceae (6 plant species) and Fabaceae (6 plant species) families with Yellow, white and pink colored flowers were visited more often for nectar collection. It could help to understand the locally available flora with different flower colors as source of food for few butterfly species and emphasized the need of herbaceous flora conservation to restore native butterfly species in various habitats.

Keywords: Butterfly species, nectar plants, PJTSAU campus, Agricultural fields, Agri-Biodiversity Park (ABP), Open scrub areas, Botanical garden.

1. INTRODUCTION

Butterflies are the most beautiful, fragile and important component of our biodiversity and they are opportunistic foragers; visit a wide variety of flowering plants thereby performing one of the key ecological processes called 'pollination' at many ecosystems (Sharma and Sharma, 2013). Interestingly, they have an intimate association with plants for their survival (Feltwell, 1986). The food plant specificity is well known among butterfly species and it is more often related with the available flora (Kumar, 2007). Many butterflies are generalists and few are specialists in their food plant preferences. Tudor *et al*. (2004) have reported the nectar feeding and flower preferences of butterflies. Nutrient sources for adult butterflies include nectar, dung, carrion, mud puddles, bird droppings, sap, rotten fruit and pollen (Opler and Krizek,1984). Of these nectar is the most common and readily available food resource for adult butterflies. During adult life, butterflies essentially require considerable quantities of proteins, salts, vitamins, etc. for longer life span and for producing greater number of eggs (Kunte, 2000). Nectar is a food for many adult butterflies visit plants with specific colored flowers for collecting nectar. Nectar is a highly enriched food resource consisting of carbohydrates, amino acids, lipids, antioxidants,

alkaloids, proteins, vitamins, salts, etc (Dafni, 1992). Butterflies do not feed indiscriminately from any flower that they might find. They prefer certain floral nectars with specific chemical composition (Kunte, 2000).

Several butterfly species show complex feeding evolutionary relationship during both adult and larval stages (Ehrlich and Raven, 1964; Sajjad *et al*. 2012). Various authors have reported the nectar plants of different butterfly species at different parts of the world. However, female butterfly's shows host plant specificity which is related with the nectar source utilization and it is correlated with time and space (Weiss and Papaj, 2003). Thus, butterfly species and their dependence on locally available flora are well established at various habitats (Tiple *et al*. 2006). Further, certain butterfly species exhibit distinct floral preference that depends on floral parameters such as color, corollary depth, clustered flowers or florets (Kunte, 2009) and chemical clues (Hern *et al*. 1996; Hooks and Johnson, 2001) of flowers. Butterflies visit yellow, orange, pink, red, white and blue colored flowers. Janz *et al*. (2005) have opined that visual cues such as shape and color of flowers play an important role for butterflies in host plants finding. Similar type of observations was made by Beck *et al*. (1999) and emphasized the butterfly preference to nectar with high sugar content (30 to 60%). Pyke and Waser (1981) have reported the plant species with tubular and bowl shaped flowers with 20 to 25% sucrose in their nectar and this has attracted butterflies more for nectar collection (Atluri *et al*. 2004). Interestingly, abundance of Satyridae, Papilionidae and Hesperiidae family members are directly correlated with the flower abundance (Arun, 2000; Arun, 2003).

2. MATERIALS AND METHODS

The study was conducted at agricultural fields (college farm, student farm and Agricultural Research Institute (ARI)), open scrub areas, Agri biodiversity park (ABP), botanical garden of PJTSAU, Rajendranagar, Hyderabad. Geographical location of Agricultural fields including the three farm areas, a) College farm (17°19'19.64" N latitude and 78° 24'29.89" E longitudes) of 542.6 meter elevation above mean sea level (MSL), b) Student farm (17°19'14"N latitude and 78°28'33" E longitude) of 542.3 meters elevation above MSL and c) ARI (17.184°N latitude and 78.240°E longitude) at an elevation of 494 meters above MSL, open scrub areas, botanical garden and ABP are at 17°18'33.19" N latitude, 78°24'57.74" E longitude and at an altitude of 559 meters from above MSL located in Rajendranagar, Hyderabad, Telangana. The experimental site, Rajendranagar, Hyderabad, Climate in Telangana is semi-arid and dry-tropical, falling under the Southern Telangana Agro Climatic Zone of Telangana state. The South West monsoon, which produces 550-850mm of rain fall annually on average, is the source of precipitation. The average temperature is 26.7°C.

Nectar plants of butterfly species were recorded by employing Visual Count Method (VCM) during nectar feeding by the butterflies in transact walk at agricultural fields (college farm, student farm, ARI), open scrub areas, ABP and botanical garden of PJTSAU campus. According to the list of observed nectar plants, they were categorized into cultivable crops,

herbs, shrubs, climbers, weeds and their flowering period was recorded as per Basavarajappa (1998), Raghunandan and Basavarajappa (2014) and observations were recorded flower colour and corolla type (tubular or non tubular). Further, flowering plants were identified with the help of field guides, published by Kehimkar (2016) and Singh and Walia (2010). Collected data was compiled and compared statistically as per Saha (1992). Analysis of variance (ANOVA) was used to know the differences between the samples by Statistical Package for Social Sciences (SPSS).

3. RESULTS AND DISCUSSIONS

A total of 37 flowering plant species belongs to 20 families were visited by butterflies during the study period (Table 1). Among the total plants recorded, flowering trees found to have contributed more (10) (27.03%) followed by weeds (9) (24.32%), cultivable crops (6) (16.22%), herbs and shrubs with same contribution (5) (13.51%) and the least contribution was found to have record with climbers (2) (5.41%) (Fig 1). Among the 20 families, Asteraceae (6 plant species) and Fabaceae (6 plant species) families were visited more often for nectar collection. Yellow, white and pink colored flowers were visited more often. Additionally, Non tubular (29) florets in inflorescence were energetically profitable for butterflies in comparison to tubular (8) flowers.

Results were in accordance with those of Santhosh and Basavarajappa (2016) who reported the nectar plants of few butterfly species and identified a total of 86 flowering plant species which belongs to 27 families. Interestingly, weeds have contributed more (49%) nectar to butterfly species followed by shrubs (14%), herbs (13%), trees (8%) and climbers (2%). Compositae (10 plant species) and Acanthaceae (8 plant species) families were visited more often for nectar collection. Yellow, white, pink and blue colored flowers were visited more often.

These findings were in accordance with those of Sengupta and Ghorai (2013) who studied plant-butterfly interaction in the surroundings of the upper Neora Valley National Park, West Bengal and recorded a total of 115 butterfly species belongs to five families and also identified 39 species of flowering plants representing 22 families as nectar resource of butterflies during the study. Orchidaceae was the dominant plant family followed by Ericaceae. White or creamish white colored flowers were preferred by a majority of butterflies. Additionally, tightly clustered florets in inflorescence were energetically profitable for butterflies in comparison to solitary flowers.

Table 1. Nectar plants of butterfly in PJTSAU campus

Commented [F1]: must correct scientific names

Family	Sl. No	Scientific name	Common name	Plant type	Colour of flower	Corolla type	Flowering season
Asteraceae	1	*Parthenium hysterophorus*	Congress grass	Weed	White	NT	TOY
	2	*Tridax procumbens*	Tridax daisy	Weed	White and yellow	NT	May – December

	3	*Erigeron bonariensis*	Horse weed	Weed	White and yellow	NT	TOY
	4	*Tagetes erecta*	Marigold	Herb	Yellow	NT	TOY
	5	*Chromolaena odorata*	Butterfly weed	Weed	White	NT	December – March
	6	*Chrysanthemum indicum*	Chrysanthemum	Herb	Orange	NT	September – December
Fabaceae	7	*Pongamia pinnata*	Karanja tree	Tree	Lavender	NT	February – June
	8	*Tamarindus indica*	Tamarind	Tree	Red and yellow	NT	April – August
	9	*Albezia lebback*	Woman's tongue tree	Tree	White	NT	March– May
	10	*Pithecellobium dulce*	Monkey pod	Tree	Whitish green	NT	March – April
	11	*Cajanus cajan*	Red gram	Cultivable crop	Yellow	NT	November – March
	12	*Senna tora*	Cassia tora	Shrub	Yellow	NT	October – February
Poaceae	13	*Cynodon dactylon*	Bermuda grass	Weed	Yellow brown	NT	March – September
	14	*Imperata cylindrica*	Cogon grass	Weed	White	NT	March – May
	15	*Rottboelliachochin chinensis*	Itch grass	Weed	Pale green	NT	TOY
	16	*Bambusa vulgaris*	Bamboo plant	Herb	Yellow	NT	December March
	17	*Setaria viridis*	Wild fox tail	Weed	Green	NT	July – September
Verbanaceae	18	*Lantana camera*	Yellow sage	Shrub	Pink and yellow	T	TOY
	19	*Duranta erecta*	Dew drop flower plant	Shrub	Lavender	T	May – September
Amaranthaceae	20	*Celosia argentea*	Silver cocks comb	Herb	Pink and white	NT	June – October
	21	*Alternanthera sessilis*	Sessile joy weed	Weed	White	NT	TOY
Meliaceae	22	*Azadiractha indica*	Neem	Tree	White and yellow	NT	January – May
Lamiaceae	23	*Ocimum tenuiflorum*	Basil	Herb	Purple to reddish	T	TOY
	24	*Tectona grandis*	Teak	Tree	White	NT	June – September
Myrtaceae	25	*Syzygium cumini*	Jamun	Tree	White	NT	March – April
Rutaceae	26	*Murraya koenigi*	Curry leaf	Tree	White	NT	April – May
Euphorbiaceae	27	*Ricinus communis*	Castor	Cultivable crop	Pink,red and	T	Sep – Nov

					Yellow		
Sapindaceae	28	*Sapindus mukorossi*	Soapnut tree	Tree	Greenish	NT	May – June
Cruciferaceae	29	*Brassica oleraracea var.capitata*	Cabbage	Cultivable crop	Yellow	NT	November
Rhamnaceae	30	*Ziziphus mauritiana*	Ber tree	Tree	Yellow	NT	July – October
Nyctaginaceae	31	*Bougainvillea glabra*	Paper flower	Climber	Pink	T	November – May
Anacardiaceae	32	*Mangifera indica*	Mango tree	Cultivable crop	White, yellow, pinkish	NT	February – March
Sapotaceae	33	*Achras sapota*	Sapota tree	Cultivable crop	White	NT	Oct- Nov and FebMar
Araceae	34	*Colocasia esculenta*	Taro	Cultivable crop	-	-	July – December
Oleaceae	35	*Jasminum officinale*	Jasmine	Shrub	White	T	March – June
Combretaceae	36	*Lumnitzera racemosa*	White flowered mangrove	Shrub	White	T	July – August
Bignoniaceae	37	*Campsis radicans*	Trumpet vine	Climber	Orange	T	July – August

*T- Tubular, NT- Non tubular, TOY- Throughout the year

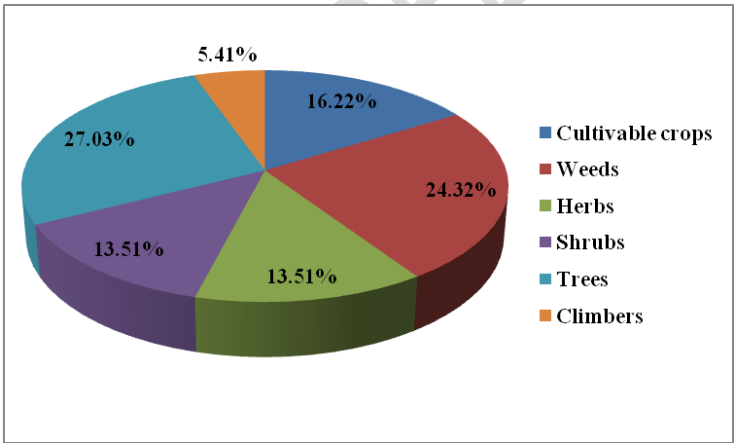


Fig. 1. Per cent composition of nectar plants in the study area

Highest number of butterflies were recorded on *Alternanthera sessilis* (20) followed by *Celosia argentea* (16), *Lantana camara* (14), *Cynodon dactylon* (13), *Parthenium hysterophorus* (9), *Sapindus mukorossi* (7), *Tridax procumbens* (6) and on *Pongamia pinnata* (4) (Table 2) (Plate 1).

Among all plant types, trees (10) recorded more followed by weeds (9) and climbers (2) were found least and more number of butterfly species were attracted to weeds (32) followed by herbs (18), shrubs (16), trees (13), cultivable crops (6) and least number of butterfly species observed on climbers (2) (Table 3).

Single and mixed flowers were observed in study area among them, white coloured flowers attracted more number of butterflies (28) followed by pink and white (16) and pink and yellow (14) (Table 4). In tubular and non tubular flowers more number of butterflies were visited to non tubular (41) followed by tubular (20) (Table 5).

These results were on par with those of Sharma and Sharma (2013) who conducted study in Gir wildlife sanctuary, Sasan, Gujarat to determine the numerous host plants associated with the beautiful butterflies. A total of 50 butterfly species recorded in Gir, highest number of butterflies were recorded in *L. camara* (19) followed by *Asclepias syriaca* (10), *Tamarindus indica* (6), *Diospyros melanoxylon* (5) and *Ixora arborea* (5), respectively.

Results were similar with those of Hasan et al. (2018) who carried out a study on an inventory of butterfly species in relation to food sources and climatic factors influencing their diversity and richness in Satchari national park and recorded a total of 195 butterfly species and six families. *L. camara* (73) had the highest recorded number of butterflies followed by *Chromolaena odorata* (60), *Leea indica* (30), *T. procumbens* (23) and *Mikania micrantha* (15). The majority of butterflies were drawn to white flowers frequently (52.2%) during nectar feeding.

During the present study, flowering trees and weeds with white and yellow coloured flowers were visited more by butterflies. Perhaps, white and yellow coloured flowers might have extended more nectar during their visit. They generally preferred non tubular flowers compared to tubular flowers to obtain good amount of nectar with in short time followed by little expenditure of energy. It could help them to reduce the energy investment relatively.

The amount of nectar present in a flower is related to foraging visits of a butterfly. In the current study highest number of butterflies were recorded on *A. sessilis*, *C. argentea* and *L. camara* was might be due to more amount of nectar present in flowers and attractive flower colour of those plants.

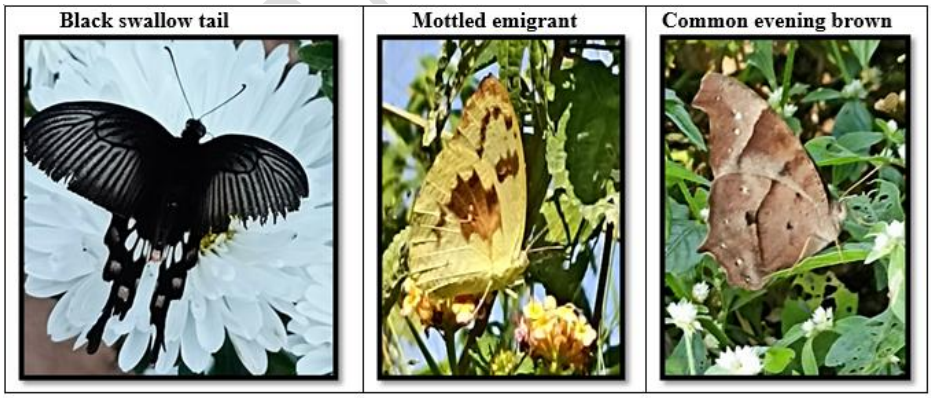
The most common species found during the study was plain tiger some species showed preference for student farm followed by ARI and college farm. Successful butterfly habitat must therefore include sufficient larval and adult food sources. In the present study, the maximum

number of species and individuals were observed in agricultural fields where availability of diverse plants and access to host plants is greater than other habitats.

Weeds also play a crucial role. So, their presence with main crop are more than other fields. Whereas, college farm and ARI fields contain less butterfly diversity because less structural complexity, flowering plants, time period and mud soils or sandy areas. Flowering plants promoted the butterfly richness and density. Most of these plants provide rich nectar sources to adult butterflies, comparatively the ARI fields have lesser density of weeds and their time period also less than college farm and student farm field due to it could also accounts for lower butterfly colonization. Each habitat has a specific set of micro environment suitable for a species. Food plants of Nymphalidae, Pieridae and Lycanidae found in the agricultural fields, whereas, other supportive plants of like food sources, basking and mating platform for adult butterflies are profoundly present in these fields. So, these fields become unique ecosystem for butterflies on the other hand butterflies become important part of these ecosystems.

Plate1. Different butterflies feeding on nectar plants.

Commented [F2]: The title should go at the bottom and scientific name of butterfly



Indian common rose 	Red pierrot 	Tawny coster 
Blue tiger 	Plain tiger 	Grass blue 
Common jezebel 	Common emigrant 	Grass jewel 

Table 2. Nectar plants and distribution of butterflies

Commented [F3]: must correct scientific names

Family	Sl. No	Scientific name	Common name	Butterflies visited
Asteraceae	1	*Parthenium hysterophorus*	Congress grass	Dark grass blue, Tawny coster, Common pierrot, Grass jewel, Plain tiger, Zebra blue, Common grass yellow, Common evening brown, Pea blue
	2	*Tridax procumbens*	Tridax daisy	Common grass yellow, Tawny coster, Grass jewel, Plain tiger, Pea blue, White orange tip
	3.	*Erigeron bonariensis*	Horse weed	Pea blue
	4.	*Tagetes erecta*	Marigold	Pea blue, Indian jezebel,Tawny coster
	5.	*Chromolaena odorata*	Butterfly weed	Common crow, Blue tiger, Plain tiger
	6.	*Chrysanthemum indicum*	Chrysanthemum	Indian jezebel, Tawny coster
Fabaceae	7.	*Pongamia pinnata*	Karanja tree	Plain tiger, Indian jezebel, Mottled emigrant, Common emigrant
	8.	*Tamarindus indica*	Tamarind	Common emigrant, Indian jezebel, Common palm fly
	9.	*Albezia lebback*	Woman's tongue tree	Indian jezebel, Common emigrant, Common rose
	10.	*Pithecellobium dulce*	Monkey pod	Indian jezebel
	11.	*Cajanus cajan*	Red gram	Tawny coster
	12.	*Senna tora*	Cassia tora	Common grass yellow
Poaceae	13.	*Cynodon dactylon*	Bermuda grass	Lemon pansy, Forget me not, Common evening brown, Mottled emigrant, Darkgrass blue, Common pierrot, Pea blue, Common cerulean, Tawny coster, Gram blue, Striped tiger, Baron butterfly, Plains cupid
	14.	*Imperata cylindrical*	Cogon grass	Common grass yellow
	15.	*Rottboelliachochin chinensis*	Itch grass	Mottled emigrant, Plain tiger, Zebra blue, Lesser grass blue
	16.	*Bambusa vulgaris*	Bamboo plant	Common evening brown
	17.	*Setaria viridis*	Wild fox tail	Dart butterfly
Verbanaceae	18	*Lantana camera*	Yellow sage	Common emigrant, Indian jezebel, Common crow, Common wanderer, Pioneer white, Great egg fly, Common rose, Plain tiger, Common emigrant, Plain tiger, Forget me not, Citrus butterfly, Lemon pansy, Tawny coster

	19	*Duranta erecta*	Dew drop flower plant	Common emigrant
Amaranthaceae	20	*Celosia argentea*	Silver cocks comb	Indian jezebel, Common crow, Red pierrot, Striped tiger, Plain tiger, Blue tiger, Tawny coster, Gram blue, Lemon pansy, Citrus butterfly, Common castor, Grass jewel, Danaid egg fly, Blue tiger, Common emigrant, Common grass yellow
	21	*Alternanthera sessilis*	Sessile joy weed	Common crow, Plain tiger, Lesser grass blue, Forget me not, Common grass yellow, Red pierrot, Grass jewel, Pioneer white, Common emigrant, Dark evening brown, Danaid egg fly, Mottled emigrant, Tawny coster, Common castor, Gram blue, African babul blue, Common pierrot, Common gull, Common leopord, Cabbage white
Meliaceae	22	*Azadiractha indica*	Neem	Indian jezebel, Common emigrant, Common rose
Lamiaceae	23	*Ocimum tenuiflorum*	Basil	Plain tiger, Common grass yellow
	24	*Tectona grandis*	Teak	Indian jezebel, Common emigrant, Danaid egg fly
Myrtaceae	25	*Syzygium cumini*	Jamun	Indian jezebel, Common crow
Rutaceae	26	*Murraya koenigi*	Curry leaf	Pioneer white, Black swallow tail, Mottled emigrant
Euphorbiaceae	27	*Ricinus communis*	Castor	Common castor
Sapindaceae	28	*Sapindus mukorossi*	Soapnut tree	Common crow, Plain tiger, Indian jezebel, Blue tiger, Common red flash, Common emigrant, Lemon pansy
Cruciferaceae	29	*Brassica oleraracea var.capitata*	Cabbage	Blue tiger
Rhamnaceae	30	*Ziziphus mauritiana*	Ber tree	Indian jezebel
Nyctaginaceae	31	*Bougainvillea glabra*	Paper flower	Common emigrant
Anacardiaceae	32	*Mangifera indica*	Mango tree	Indian jezebel, Baron butterfly
Sapotaceae	33	*Achras sapota*	Sapota tree	Indian jezebel
Araceae	34	*Colocasia esculenta*	Taro	Plain tiger
Oleaceae	35	*Jasminum officinale*	Jasmine	Indian jezebel, Crimpson rose, Common rose
Combretaceae	36	*Lumnitzera racemosa*	White flowered mangrove	Yellow orange tip, White orange tip
Bignoniaceae	37	*Campsis radicans*	Trumpet vine	Common wanderer

Table. 3. Number of butterfly species visited plants

Sl. No.	Plant type	No. of plant species	No. of butterfly species
1.	Weeds	09	32
2.	Herbs	05	18
3.	Shrubs	05	16
4.	Cultivable crops	06	06
5.	Trees	10	13
6.	Climbers	02	02

Table. 4. Number of butterfly species attracted to flower colors

Sl. No.	Flower colour	Number of butterfly species attracted
1.	White	28
2.	White and yellow	09
3.	Yellow	06
4.	Orange	03
5.	Lavender	04
6.	Red and yellow	03
7.	Whitish green	07
8.	Yellowish brown	13
9.	Pale green	05
10.	Pink and yellow	14
11.	Pink and white	16
12.	Reddish purple	02
13.	Pink, red and yellow	01
14.	Pink	01
15.	White, yellow and pink	02

Table. 5. Number of butterflies visited to tubular and non tubular flowers

Sl. No.	Corolla type	No. of plants	No. of butterflies visited
1.	Tubular (T)	08	20
2.	Non tubular (NT)	29	41

4. CONCLUSION

Butterflies showed a clear preference for flowering trees and weeds with yellow, white and pink colored flowers being their top choices. Non tubular florets inflorescence were energetically more profitable for butterflies than tubular flowers during nectar collection. *Alternanthera sessilis*, *Celosia argentea* and *Lantana camara* attracted the highest number of butterflies making it the most preferred plant for butterfly activity.

REFERENCES

Arun PR. Butterflies of Siruvani Forest of Western Ghats, with notes on their seasonality. Zoo's Print J. 2003; 18(2):1003-1006.

Arun PR. Seasonality and abundance of insects with special reference to butterflies (Lepidoptera: Rhopalocera) in moist deciduous forest of Siruvani, Nilgiri Biosphere Reserve, South India (Ph. D., Thesis). Bharathiar Uni., Coimbatore. 2000, 200-236.

Atluri JB, Venkataramana SP, Subbareddi C. Eco-biology of the common rose butterfly Pachliopta aristolochiae (Lepidoptera: Rhopalocera: Papilionidae). Proc. AP. Academic. Sci. 2004; 8(2):147-154.

Basavarajappa, B.S., Cooper, T.B and Hungund, B.L. Chronic ethanol administration downregulates cannabinoid receptors in mouse brain synaptic plasma membrane. Brain Research. 1998; 793(1-2): 212-218.

Beck J, Miihlenberg E, Fiedler K. Mud-puddling behaviour in tropical butterflies: In search of proteins or minerals? Oecologia. 1999; 119:140-148.

Dafni, A., 1992. *Pollination ecology: a practical approach*. Oxford University Press. 229.

Ehrlich PR, Raven PH. Butterflies and plants: A study in conservation. Evolution. 1964; 18(4):586-608.

Feltwell J. The Natural History of Butterflies. Groom Helem Ltd., Provident House, Bureel Row. Beckenham Kent. 1986; 130-135.

Hasan, M.A.U. An inventory of butterfly species in relation to food sources and climatic factors influencing their diversity and richness in a semi evergreen forest of Bangladesh. Arthropods. 2018; 7(3): 53.

Commented [F4]: Italics

Hern A, Edwards-Jones GA, Mckinlay RG. A review of the pre-oviposition behaviour of small cabbage white butterfly, pieris rapae (lepidoptera: pieridae). annals of applied biology. 1996; 128(2):349-71

Hooks CR, Johnson MW. Broccoli growth parameters and level of head infestations in simple and mixed plantings: Impact of increased flora diversification. Annals of Applied Biology. 2001; 138(3):269-80.

Janz N, Bergstrom A, Sjogren A. The role of nectar sources for oviposition decisions of the common blue butterfly Polyommatus icarus. OIKOS. 2005; 109:535- 538.

Kehimkar, I. Butterflies of India. Bombay Natural History Society. Mumbai, India. 2016.

Kumar PMPM, Hosetti BB, Poomesha HC, Gowda RHT. Butterflies of the Tiger-Lion Safari, Thyavarekoppa, Shimoga, Karnataka. Zoo's Print J. 2007; 22(8):2805.

Kunte K. Occurrence of Elymnias obnubila Marshall and de Niceville, 1883 (Lepidoptera: Nymphalidae: Satyrinae) in southern Mizoram; range extension of the species and an addition to the Indian butterfly fauna. J Threatened Taxa. 2009; 1(11):567-568.

Kunte, K. *India, a life Scape: Butterflies of peninsular India*. Universities Press. 2000; 254.

Opler, P.A. and Krizek, G.O. Butterflies east of the Great Plains: an illustrated natural history. 1984; 273-279.

Pyke GH, Waser NM. The production of dilute nectars by hummingbird and honeyeater flowers. Biotropica. 1981; 260-70.

Raghunandan, K.S and Basavarajappa, S. Incidence of Galleria mellonella infestation on Apis dorsata colonies at different regions of South-Western Karnataka. Zoology. 2014; 3(2).

Saha, P. Simulating the 3:1 Kirkwood gap. Icarus. 1992; 100(2): 434-439.

Sajjad A, Saeed S, Burhan-u-din S. Yearlong association of butterfly populations with flowering plants in Multan, Pakistan. Pak. Entomology. 2012; 34(2):105-110.

Santhosh, S and Basavarajappa, S. Study on nectar plants of few butterfly species at agriculture ecosystems of Chamarajanagar District, Karnataka, India. International Jounal of Entomological Research. 2016; 1(5): 40-48.

Sengupta, P. and Ghorai, N. On the plant-butterfly interaction in the surroundings of the upper Neora Valley National Park, a sub-tropical broad leaved hill forest in the eastern Himalayan landscape of West Bengal, India. An International Journal of Environmental Biology. 2013; 4(4): 21-30.

Commented [F5]: *Pieris rapae*

Commented [F6]: Lepidoptera:Pieridae

Commented [F7]: italics

Commented [F8]: italics

Commented [F9]: italics

Sharma M, Sharma N. Nectar resource use by Butterflies in Gir-Wildlife Sanctuary, Sasan, Gujarat. Biol. Forum. J. 2013; 5(2):56-63.

Sharma, M and Sharma, N. Nectar resource use by Butterflies in Gir Wildlife Sanctuary, Sasan, Gujarat. Biological Forum. 2013; 5(2): 56-63.

Singh S and Walia US. Identification of Weed and their Control Measures. Science Publication, India. 2010; 3-86.

Tiple AD, Deshmukh VP, Dennis RLH. Factors influencing nectar plant resource visits by butterflies on a Uni. Campus: implications for conservation. Nota lepida. 2006; 28(3/4):213-224.

Tudor O, Dennis RLH, Davies JNG, Sparks TH. Flower preferences of woodland butterflies in the UK; nectaring specialists are species of conservation concern. Biol. Conserve. 2004; 119:397-403.

Weiss MR, Papaj DR. Center for Insect Science, Tucson Color learning in two behavioral contexts: how much can a butterfly keep in mind? Animal. Behave. 2003; 65:425- 434.

Weiss MR. Innate color preferences and flexible color learning in the pipevine swallowtail. Animal. Behave. 1997; 53:1043-1052.