

# **BUTTERFLY GARDENING: LANDSCAPING FOR AESTHETICS AND BUTTERFLY CONSERVATION**

By

**Rashidha. C.K (2018-12-011)**

M.Sc. Floriculture and Landscaping

Seminar report submitted in partial fulfillment of requirement of course

FLA 591: Master's Seminar (0+1)



**DEPARTMENT OF FLORICULTURE AND LANDSCAPING**

**COLLEGE OF HORTICULTURE**

**KERALA AGRICULTURAL UNIVERSITY**

**VELLANIKKARA – 680656**

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## **DECLARATION**

I, Rashidha.C.K. (2018 -12- 011), hereby declare that the seminar report entitled ‘Butterfly gardening: Landscaping for aesthetics and butterfly conservation’ has been completed by me independently after going through the reference cited herein and I have not copied from any of the fellow students or previous seminar reports.

Vellanikkara

25 – 01 – 2020

Rashidha. C.K.

(2018-12-011)

## **CERTIFICATE**

This is to certify that the seminar report entitled 'Butterfly gardening: Landscaping for aesthetics and butterfly conservation' has been solely prepared by Rashidha. C.K. (2018 -12- 011), under my guidance and has not been copied from seminar reports of seniors, juniors or fellow students.

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Certified that the seminar report entitled 'Butterfly gardening: Landscaping for aesthetics and butterfly conservation' is a record of seminar presented by Rashidha. C.K. (2018 -12-011) on 22<sup>nd</sup> November, 2018 and is submitted for the partial requirement of the course FLA 591.

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## 1. Introduction

Butterflies are the most fascinating creatures existing on earth and have great aesthetic value. From ecological standpoint, they are indicators of biodiversity and environmental health. They procure nectar from flowering plants and serve as the pollinators of various plant species. Attracting this fascinating insects to the garden can add an ever changing mural colour and motion to the landscape.

A butterfly garden is a specifically planned space to attract and keep butterflies supplied with the basic elements that they need for their survival *viz.* food, sunlight, water and shelter. (Tekulsky, 1985). Butterfly gardening is a delightful hobby and offers physical, emotional, intellectual and social benefits to people are engaged in it.

A butterfly garden consists of components such as butterflies, host plants, nectar plants, garden adornments as well as area for specific butterfly activities *viz.*, puddling, perching, patrolling and basking. Host plants are the plants on which butterflies lay eggs and the emerging caterpillars feed on parts of it. Nectar plants provide nectar and sustain adult butterflies. Garden adornments are the items which attract the butterflies and enhance the beauty of garden. Butterfly house, feeders and hibernating boxes are commonly used in butterfly garden to enrich the aesthetic value. Butterfly garden designing strategies are based on the life cycle of butterflies, their needs and behaviours. A system of selecting icons and plugging them into the design at various stages ensures a simplistic but comprehensive approach for building the butterfly garden.

Butterflies are considered good environmental indicators that particularly depend on diversity of flora and vegetation structure. However human effect, land use, climate and other factors are affecting the distribution and diversity of butterflies. Vegetation structure and plant species are important constituent on butterfly population. Urban landscape can be the potential areas for butterfly species *via* butterfly gardens. The identification and evaluation of plants within their attractive characteristics are important for planning and design of a butterfly garden. By providing the right types of plants, shelter, water and a safe haven for them to lay their eggs, butterflies can be attracted to garden. Establishment of butterfly garden helps to increase butterfly diversity and abundance in urban as well as in suburban areas and conserving species that might otherwise become rare or even disappear.

## 2. Benefits of butterfly gardening

The primary benefits of designing butterfly gardens are:

- **Landscape for aesthetic:**

It provide a peaceful place to enjoy. Butterflies bring a sense of excitement to a flower garden and are relaxing and uplifting at the same time. Butterfly gardens are a simple and easy way to improve people's quality of life and beautify a community or backyard.

- **For conservation of butterflies:**

For the conservation of wildlife, Establishment of butterfly garden helps to increase butterfly diversity and abundance in urban as well as in suburban areas and conserving species that might otherwise become rare or even disappear.

- **Flower pollination:**

Butterflies also serve as flower pollinators and attracting the butterflies can also assist in the pollination of nearby plants

- **Food sharing:**

These insects also provide food for other organisms, for example; birds, reptiles amphibians and also acts as biological pest control

- **Public education:**

Butterfly gardening can also serve as an educational opportunity for children and can be a relatively safe way to introduce them to the natural world.

As job training they are used to teach general as well as specialized job skill.

- **Gardening for recreation,therapy:**

Butterfly gardening can be used in a therapeutic setting to meet the need of different population. As therapy, horticultural activities are used in treatment programme with defined goal for patients. Butterfly gardening can be used as a recreational programmes in nursing homes or senior citizen centers.

- **Financial gain :** as a result of the increasing value of eco-friendly property

### 3. Components of butterfly garden

There are 4 basic components of butterfly garden

1. Butterflies
2. Host plants
3. Nectar plants
4. Garden adornments and other accessories

#### 3.1 Butterflies

Butterflies are beautiful, flying insects with large scaly wings. The ephemeral beauty of the butterfly and the peculiarity of its life cycle symbolize transformation in nature and the passage of time. In some languages the word for "butterfly" is the same as that for "soul. Butterflies have long fascinated humans. Butterflies are engaging and iconic animals of a garden. People are drawn to butterflies because of their beauty, grace and their sense of freedom.

##### 3.1.a. Importance of Butterflies in Nature

*Butterflies may be better indicators of the health of our environment than birds*

— Roger Tory Peterson

##### i. As pollinators of crops and other flowers

Butterflies serve as important plant pollinators in the local environment and help pollinate hundreds of economically important plant crops. The role played by pollination and cross pollination in the development of crop varieties and evolution of plants is immense.

##### ii. Our Natural Heritage

Butterflies are the natural heritage of our country. The entire biodiversity is the treasure trove which got from ancestors and need to preserve them. Butterflies are flagship species for conservation in general, and in particular for invertebrates.

##### iii. Intrinsic value

Butterflies and moths are intrinsically valuable and are worthy of conservation in their own right. Butterflies and moths are part of the life on the earth and an important component of its rich biodiversity. They have been around for at least 50 million years and probably first evolved some 150 million years ago. They are a highly diverse group comprising over 250,000 species and make up around one quarter of all named species.

**iv. Aesthetic value**

Butterflies and moths are beautiful. Humans love all beautiful things in nature. They add to the aesthetic value of any natural landscape and heritage. Butterflies have been studied for over 300 years by humans. There are many references to butterflies and moths in literature, from the Bhagwat Gita to Bible through Indian folklore modern day literature, and from poetry to musical lyrics. Butterflies are used by advertisers and illustrators the world over as way of indicating that something is environmentally friendly. They are often portrayed as the essence of nature or as representing freedom, beauty or peace.

**v. Educational value**

Butterflies and moths have fascinating life-cycles that are used in many countries to teach children about the natural world. The transformation from egg to caterpillar to chrysalis is one of the wonders of nature. Other educational aspects include the intricate wing patterns and iridescence, and as examples of insect migration.

**vi. Scientific value**

Butterflies (and moths to a lesser extent) are an extremely important group of ‘model’ organisms used, for centuries, to investigate many areas of biological research, including such diverse fields as navigation, pest control, embryology, mimicry, evolution, genetics, population dynamics and biodiversity conservation.

**v. Ecosystem value**

Butterflies and moths are indicators of a healthy environment and healthy ecosystems. Areas rich in butterflies and moths are rich in other invertebrates which collectively provide a wide range of environmental benefits, including pollination and natural pest control. Moths and butterflies are an important element of the food chain and are prey for birds, bats and other insectivorous animals. As Indicators of the health of environment butterflies have been widely used by ecologists as model organisms to study the impact of habitat loss and fragmentation, and climate change.

**iv. Health value**

People enjoy seeing butterflies both around their homes and in the countryside. Social media groups of butterfly lovers in India have more than 20,000 members. These people photograph, survey and share butterfly information on social media. They travel thousands of kilometers in search of butterflies. Now, butterfly gardening is becoming an important passion

and it is now popular in India. People feel distressed in the company of butterflies and they love to watch and photograph them.

#### **vii. Economic value**

Thousands of people visit India each year looking for butterflies. Eco-tourism and now butterfly tourism is bringing in valuable income to many local tribes and butterfly garden owners across the country. Sikkim, Arunachal Pradesh, Assam, Kerala and Maharashtra have become hubs of butterfly tourism and related businesses.

#### **3.1.b. Butterflies are unique:**

Butterflies are the adult flying stage of certain insects belonging to an order or group called Lepidoptera. Moths also belong to this group. The word "Lepidoptera" means "scaly wings" in Greek. This name perfectly suits the insects in this group because their wings are covered with thousands of tiny scales overlapping in rows. The scales, which are arranged in colorful designs unique to each species, are what gives the butterfly its beauty". Like all insects, they have six jointed legs, 3 body parts, a pair of antennae, compound eyes, and an exoskeleton. The three body parts are the head, thorax (the chest), and abdomen (the tail end).

#### **3.1.c. Butterfly life cycle**

A life cycle is made up of the stages that a living organism goes through during its lifetime from beginning to end. A butterfly undergoes a process called complete metamorphosis during its life cycle. This means that the butterfly changes completely from its early larval stage, when it is a caterpillar, until the final stage, when it becomes a beautiful and graceful adult butterfly. The butterfly life cycle has four stages: egg, larva, pupa, and adult.

#### **3.1.d. Butterfly diversity**

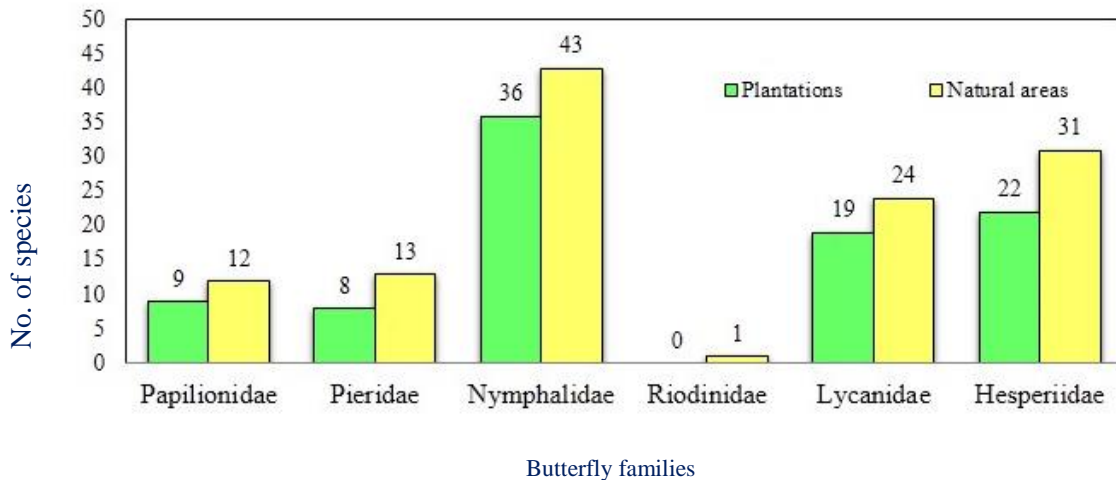
There are about 17,500 species of butterflies in the world, around 1500 species found in India and 314 species seen in Kerala.

The study the diversity and seasonal abundance of butterflies in the Butterfly Safari at Thenmala in Kerala shows that Nymphalidae with 42 species was the most dominant family followed by Lycaenidae (22 species), Papilionidae (15 species), Hesperidae (11 species) and Pieridae (9 species).The butterfly population showed an increasing trend during the monsoon

season (June-October) reaching its peak in November. The population remained low during the summer months (March-May). The study showed the significant benefit of such parks in biodiversity conservation, recreation and education (Sankaranarayanan *et al.*, 2018)

A study conducted in Kerala Agricultural University (KAU) campus, Thrissur, Kerala to identify the abundance and distribution of butterflies in two broad habitats by Aneesh *et al.* (2013) reported that total of 139 species of butterflies belonging to six families were identified from the KAU campus, including four species that are endemic to the Western Ghats and nine species protected under various schedules of the Indian Wildlife. The family-wise distribution of butterflies of KAU campus shows that Nymphalidae (brush-footed butterflies) dominated the butterfly fauna of KAU campus with 44 species followed by Lycaenidae (blues) 35 species, Hesperidae (skippers) 34 species, Pieridae (whites and yellows) 13 species, Papilionidae (swallow-tails) 12 species, and Riodinidae (1) with a single species (Fig. 1). Among the two broad habitat types at KAU, species richness was found to be more in natural areas with 124 species followed by plantations.

**Fig.1. Family wise distribution and habitat preference of butterfly species in Kerala Agricultural University campus (Aneesh *et al.* 2013)**



**Plate 1. Butterflies in Kerala Agricultural University (KAU) campus**

**FAMILY : Papilionidae**



*Troides minos*  
(Southern Birdwing)



*Pachliopta hector*  
(Crimson Rose)



*Graphium sarpedon sarpedon*  
(Common Bluebottle)



*Graphium doson*  
(Common Jay)



*Graphium Agamemnon*  
(Tailed Jay)



*Papilio clytia*  
(Common Mime)

**FAMILY : Pieridae**



*Catopsilia pomona*  
(Common Emigrant)



*Eurema hecabe*  
(Common Grass yellow)



*Eurema brigitta*  
(Small Grass Yellow)



*Eurema blanda*  
(Three-spot Grass Yellow)



*Delias eucharis*  
(Common Jezebel)



*Appias lyncida*  
(Chocolate Albatross)

**Plate 2. Butterflies in Kerala Agricultural University (KAU) campus**

**FAMILY : Nymphalidae**



*Limenitis procris*  
(Commander)



*Tirumala limniace*  
(Blue Tiger)



*Tirumala septentrionis*  
(Dark Blue Tiger)



*Junonia lemonias*  
(Lemon Pansy)



*Junonia almanac*  
(Peacock Pansy)



*Hypolimnna bolina*  
(Great Eggfly)

**FAMILY : Lycaenidae**



*Graphium doson*  
(Common Jay)



*Euchrysops nejus*  
(Gram Blue)



*Talicauda nyseus*  
(Red Pierrot)

**FAMILY : Hesperidae**



*Halpe porus*  
(Moore's Ace)



*Ampittia dioscorides*  
(Bush Hopper)



*Telicota colon*  
(Pale Palm Dart)



### 3.1.e Butterfly behaviour or butterfly activities in garden

#### i. Feeding :

The larval or caterpillar stage and the adult butterfly have very different food preferences, largely due to the differences in their mouth parts. Host plant serve as food source for caterpillars. Caterpillars have chewing mouth parts, called mandibles, which enable them to eat leaves and other plant parts. Caterpillars do not need to drink additional water because they get all they need from the plants they eat. Adult butterflies are able to feed only on various liquids. They drink through a tube-like tongue called a proboscis. It uncoils to sip liquid food, and then coils up again into a spiral when the butterfly is not feeding. Most butterflies prefer flower nectar, but others may feed on the liquids found in rotting fruit, in ooze from trees, and in animal dung.

#### ii. Basking:

Butterflies are cold-blooded, meaning they cannot regulate their own body temperature. Their body temperature changes with the temperature of their surroundings. If they get too cold, they are unable to fly and must warm up their muscles in order to resume flight. Butterflies can fly as long as the air is between 60°-108° F, although temperatures between 82°-100° F are best. If the temperature drops too low, butterflies bask with their wings spread out in order to soak up the sun's heat. Butterflies will bask on rocks, wood decks, gravel roads, dirt paths, cement patios, leaf and brick in a sunny spot.

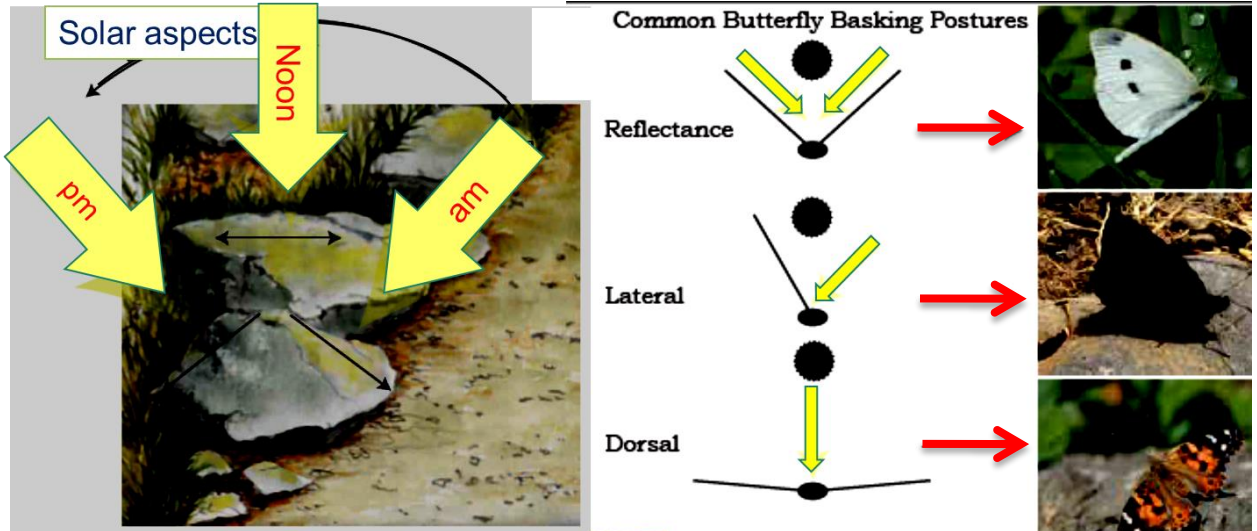
Butterflies will bask continuously throughout the day based on environmental factors such as the availability of sunlight and ambient temperatures. One of the most important factors in designing a garden that promotes basking is creating microclimates that receive full sun and wind shelter in the early hours of the day.

**Types of basking:** (Kemp, 2002)

1. **Reflectance basking:** It is one form of basking. Butterflies that use reflectance basking have wings that reflect the light. The wings reflect the light into the body. This heats the body up so the butterfly can fly. For this type of basking the lighter in color the scales the better.
2. **Lateral basking:** Lateral baskers sit with their wings closed. These butterflies have dark scales underneath their wings that absorb heat. Because early spring butterflies have darker wings, their bodies will absorb heat more rapidly. eg: Clouded Sulfur.

3. **Dorsal basking:** In dorsal baskers and sit with their wings open to get the full benefit of the sun. They will also lie close to the ground so that they can absorb the heat from the ground as well. eg: Monarchs and Painted Lady

**Plate 3. Common Butterfly Basking Postures**



Basking stones are an excellent design feature to place in sunny locations within the garden. The stones absorb heat and provide a reflective surface that radiates heat back into the butterfly's body. Most literature suggests placing stones in a sunny location that receives at least six hours of sun will provide a better space for basking. Dark colored stones such as basalt absorb and thus retain heat longer than lighter colored stones, giving off heat at a higher rate. Flat surface stone and angling a stone towards the sun is more effective to accommodate all basking species. Butterflies have a visual acuity distance of approximately 12 feet, creating basking areas that provide sunny areas of a 10-15 foot area should promote butterfly basking while engaging in perching behavior simultaneously.

### 3P' s

#### iii. Puddling

During the warm months, Male butterflies seek moisture during the warm months along streambanks, lake-side shorelines, seeps, springs, mud puddles after a rain, or over-spray runoff from irrigation. Although the surface water is a vital source of hydration, it is the dissolved minerals such as sodium (salts) within the wet ground that the butterflies are after. This source of nutrition from puddling cannot be provided by the rich carbohydrate diet of nectar. The sodium

and amino acids found within the mineral deposits of the soils are paramount for sperm development and maturation. During mating the male transfers stored minerals from his puddling efforts into the female. These nutrients help in the survivability of the egg clutch. (Boggs, 1991; Coetzer, 2014).

The behavior of puddling in nature translates to the building of a puddling station in the butterfly garden. Many homemade butterfly puddle station designs advocate for a puddle station to be made from a shallow bird bath sized saucer, filled with sand and a bit of manure to provide salts and proteins. This is a simple and inexpensive way to create a butterfly puddle station.

Puddle station should receive full sun during the warmest time of the day (10 am to 4 pm is perfect). Place tall vegetation (trees and shrubs) will provide shelter from wind without creating shade across the puddle station. Make the area will receive a fresh supply of water through the hottest and driest months. Place the station where the wet soil will be free from vegetation.

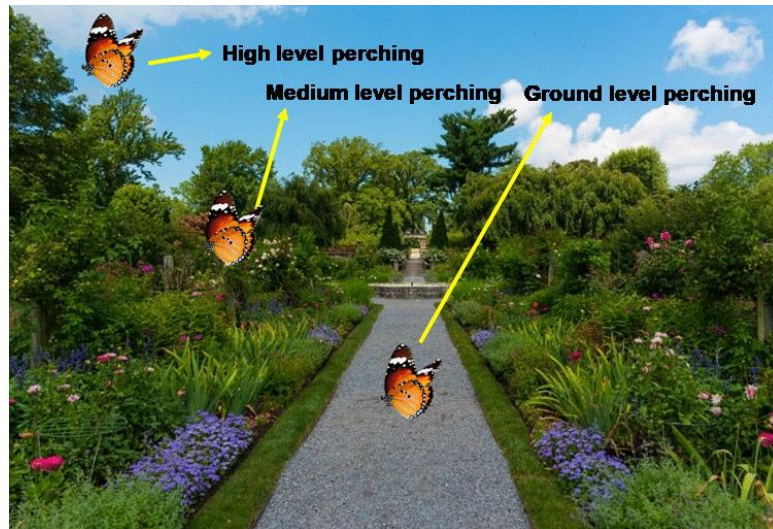
#### iv. **Perching**

Perching is a mate-location behavior exhibited by male butterflies of certain butterfly species. In perching, male butterflies will pick out a strategic spot in their habitat that will provide them with a favorable vantage point for locating female butterflies. Perches are generally used by a solitary male for one to several days. Males will rest atop vegetation, on a rock or bare earth. Male butterflies that have established a perch will defend that location from other rival males that enter their territory.

The perch is generally an object that the butterfly can rest atop with a clear view in all directions to detect oncoming females, ward off would-be rival males, or detect danger from predators (Dennis 1988).

Perching stations should be a gradient of mixed height vegetation, structured in a way that allows a perching male to have an unobstructed view of an open area. A ground perching species should be given a gravel or bare earth pad, free from vegetation. A large shrub perching species should have plants planted on the edge of a clearing or pathway. Because butterfly visual acuity is roughly 10-12 feet. Perches should be given adequate space for males to clearly see objects entering their perching zones. If multiple perching stations are designed within a garden, separating them beyond a butterfly's visual range will decrease conflict between rival males.

#### Plate 4. Spatial relationships of perching butterfly species to their environment



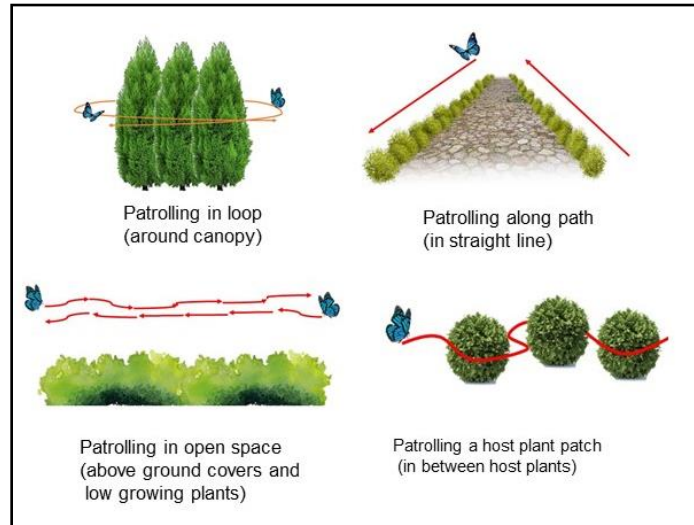
#### v. **Patrolling**

Patrolling is a mate finding behavior exhibited by specific species, in which butterflies continuously fly within their habitat looking for mates. Generally, both sexes of a patrolling species engage in this behavior, with the male playing a more dominant mate-locating role. Patrolling species engage in this behavior throughout the day and thus are likely to mate at any time during flight Hours. Each butterfly species patrols their environment in their own unique way.

Because patrolling species need to be in constant flight, the habitat needs to be conducive for flight. Creating the vegetation structure that resembles their preferred habitat is key. The habitat garden needs to be bathed in sunshine during the butterfly's patrolling hours. All areas of the garden should be filled with full sun from 9am until 5pm. Keep shaded areas along the sides rather than crossing through the middle of the garden space. The area should receive plenty of wind protection by establishing protective wind buffering vegetation stands to keep the garden warm and butterflies in the air. Many patrolling species patrol in areas where their hostplant grows. Distributing the hostplant evenly throughout the garden can help patrolling species gives more space to patrol, promoting more butterflies within the garden. Plant plenty of nectaring plants to keep patrolling butterflies well-nourished as patrolling behavior is very energy intensive.

Specific vegetation types and structure would promote the different patrolling species behaviors. Some species will patrol on top Patrolling in open space (above ground covers and low growing plants). Some species will patrol open trails and pathways. Some species will fly in a loop-like pattern, others will patrol above hostplant patches.

**Plate 5. Specific butterfly species patrolling behavior**



**vi. Hibernating**

Butterflies are cold-blooded and cannot withstand winter conditions in an active state. Butterflies may survive cold weather by hibernating in protected locations. They may use the peeling bark of trees, perennial plants, logs or old fences as their overwintering sites. They may hibernate at any stage (egg, larval, pupal or adult) but generally each species is dormant in only one stage.

A log pile is an excellent addition to any wildlife garden. It provides shelter for many small mammals and amphibians as well as butterflies. Butterflies may use log piles for perching, roosting, and hibernation. Hibernating boxes are also available.

### 3.2 Host plants

A butterfly host plant is a species of plant that the larval stage of the butterfly, the caterpillar, uses as its primary food source. Generally, the caterpillar feeds exclusively on the leaves of its host plant, but there are species that feed on the flowers, stems and young seedpods. Most butterfly caterpillars spend their entire larval life cycle feeding on a single species of plant, often on the same plant on which they hatched from as an egg. (Tekulsky 1985).

Some species of butterflies are host plant specific, using only one species or one family of plants to serve as an adequate food source. The Monarch butterfly, which only feeds on plants in the milkweed family, is one such species. This narrow range of host plant usage is termed a “feeding specialist”. Other butterfly species will use a wide range of host plants to carry out their caterpillar development. This type of wide range of host plant usage is termed a “feeding generalist”. Host plants are generally native plants that are found growing naturally within the region where the butterfly occurs.

Some of the native host plants play a vital role in attracting butterflies and increasing the diversity of butterflies. The study conducted in Pachamalai hills of Eastern Ghats in Tamilnadu shows that *Vitex negundo*, which acts as a primary nectar host plant for a variety of butterfly species (Gidion *et al.*, 2016).

**Table.1. Number of species visiting different plant species (Gideon *et al.*, 2016)**

Sl.no	Butterfly family	No. of butterfly species visited		
		<i>Vitex negundo</i>	<i>Ehretia pubescens</i>	<i>Premna serratifolia</i>
1	Papilionidae	7	4	2
2	Pieridae	5	4	5
3	Nymphalidae	13	6	12
4	Lycaenidae	2	0	2
5	Hesperiidae	1	1	1
	Total	28	15	22

Host plant dispersal is a key consideration. Host plants should be planted throughout the garden in evenly spaced patches. Dispersing the hostplants over a greater area helps ensure that female butterflies will visit a greater amount of plants as they fly throughout their environment and deposit more eggs within the garden. The spreading out of the hostplants helps ensure that not all caterpillars will be concentrated in one location, making it harder for predatory insects and birds to find them as well as reducing food competition between caterpillars (Masumoto, 1993).

**Table.2. Common host plants and specific butterflies found in Kerala**

<b>Butterfly</b>	<b>Host plant</b>
<i>Pachliopta hector</i> (Crimson rose)	<i>Aristolochia indica</i>
<i>Pachlioptara istolochiae</i> (Common rose)	<i>Aristolochia indica</i>
<i>Troides minos</i> (Southern bird wing)	<i>Aristolochia indica</i> , <i>Thottea siliquosa</i>
<i>Graphium doson</i> (Common jay)	<i>Michelia champaca</i>
<i>Graphium agamemnon</i> (Tailed jay)	<i>Michelia champaca</i> <i>Annonasp.</i>
<i>Graphium sarpedon</i> (Blue bottle)	<i>Cinnamomum verum</i>
<i>Papilio demoleus</i> ( Lime butterfly)	<i>Citrus</i> sp.
<i>Papilio polytes</i> (Common mormon)	<i>Citrus</i> sp.
<i>Catopsilia pomona</i> (Common emigrant)	<i>Cassia</i> sp.
<i>Eurema hecabe</i> (Common grass yellow)	<i>Cassia</i> sp. <i>Caesalpinia pulcherrima</i>
<i>Danus chrysippus</i> (Plain tiger)	<i>Calotropis gigantean</i>
<i>Tirumala limiace</i> (Blue tiger)	<i>Wattakaka volubilis</i>
<i>Danus genutia</i> (Striped tiger)	<i>Asclepias curassavica</i>
<i>Moduza Procris</i> (Commonander)	<i>Mussaenda laxa</i>

## Plate 6. HOST PLANTS

### TREES



*Atalantia racemosa*  
Kattunarakam



*Polyalthia longifolia*  
Aranamaram



*Cassia fistula*  
Kanikonna



*Murraya koenigii*  
Kariveppu



*Cassia sophera*  
Ponthakara



*Miliusa tomentosa*  
Kana



*Michelia champaca*  
Chambakam



*Cinnamomum verum*  
Karuvapatta



*Albizzia lebbek*  
Kattuvaka

### CLIMBERS



*Quisqualis indica*  
Nakshthra mulla



*Passiflora edulis*  
Passion fruit



*Aristolochia indica*  
Garudakkodi



## Plate 7. HOST PLANTS

### SHRUBS



*Glycosmis arborea*  
Paanal



*Wattakaka volubilis*  
Vattakkakkakodi



*Tylophora indica*  
Vallippala



*Asclepias curassavica*  
Kammalchedi



*Ricinus communis*  
Avanakku



*Caesalpinia pulcherrima*  
Rajamalli

### HERBS



*Kalanchoe laciniata*  
Paaramashi



*Kalanchoe pinnata*  
Ilamulachi

### **3.3 Nectar plants**

The most familiar component of the butterfly garden, besides the butterfly, is the flower. Flowers produce a sweet, carbohydrate rich liquid called nectar. Not only does nectar sustain the adult butterfly for energy needed for daily activity, nectar contains vital amino acids that aid in reproduction (Mevi-Schutz, 2005).

The sole purpose of the nectar is to offer a reward to the visiting pollinator, and in exchange, the flower is fertilized. For most butterflies, nectar makes up the majority of the adult butterfly's diet (Tekulsky 1985).

Specifically designing for butterfly nectar sources requires the designer to pay attention on the species of flowering plants that will be placed within the garden space, flower color, bloom time, sun requirements and the arrangement of these plants both spatially and structurally. The flower garden structure should show the tallest flowers blooming towards the back or center of flower massing and the shortest flowers towards the front or pathways. The choice of native plants that have regionally evolved with local butterfly species should continue to be the primary choice for nectar sources.

Butterflies are often considered opportunistic foragers that visit a wide variety of host plants and nectar plants. The choice of plants as nectar sources by butterflies depends on innate color preference, corolla depth, clustering of flowers from which nectar can be extracted.

Most adult butterflies feed on a variety of flower types. Shape, color, height, fragrance and time of bloom. All these factor contribute flower choice and frequency of visitation by butterflies (Tekulsky 1985).

#### **Bloom time:**

It is important to consider, provide plenty of flowering plants within the garden that bloom at different times throughout the season.

#### **Color**

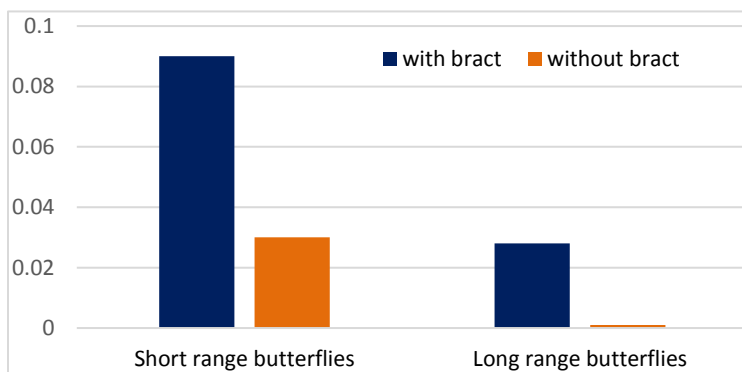
Butterflies display a wide color preference range within flower groups and show a wide range of food foraging strategies. Butterflies possess excellent color vision. Although any flower color has the potential for attracting nectar seeking butterflies, butterflies are most attracted to purple, white, yellow and pink.

Planting flowers in specific quantities and in certain arrangements is important for butterflies to locate these nectar sources. Butterflies are naturally nearsighted and massing flowering plants in large colorful blocks and drifts will help butterflies locate the nectar sources more easily and keep their attention, thus keeping them flying about the garden (Yturralde, 2009). The flower garden structure should show the tallest flowers blooming towards the back or center of flower massing and the shortest flowers towards the front or pathways (Xerces Society 1990).

Hence to understand the butterfly-flower interactions, a study was conducted by Sharma *et al.* (2013) in Gir Wildlife Sanctuary, Sasan, Gujarat to determine the numerous host plants associated with these beautiful butterflies. An extensive entomological survey for a period of two years in the forest area of Gir was undertaken. Out of the 50 butterfly species recorded in Gir, 27 species (54%) used nectar while other species obtained their food from non-floral resources such as mud, wet soils and cow dung. Highest number of butterflies were recorded in *Lantana camara* (19), followed by *Asclepias syriaca* (10), *Tamarindus indica* (6), *Diospyros melanoxylon* (5) and *Ixora arborea* (5) respectively. They also observed that flower color and size also influence the visiting insects, therefore majority of butterflies were attracted to white flowers (36.36%). This was followed by yellow (29.09%), red (20%) and green (14.55%) respectively.

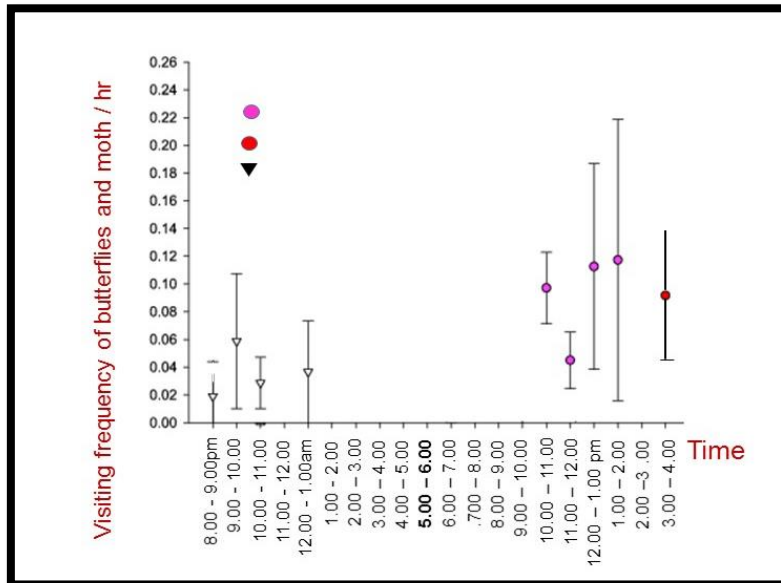
In butterfly-pollinated *Mussaenda frondosa* (Rubiaceae), flowers attract pollinators at short distances while conspicuous, non-rewarding accessory bracts are detectable at long distances by long-ranging pollinators such as the birdwing butterfly *Troides minos* that did not detect flower-bearing plants in the absence of these bracts (fig.2). However, even in the absence of flowers, the white, ultraviolet-absorbing bracts attracted butterflies that visited flowerless plants. This study was conducted by Borges *et al.*, 2003 by removing bract resulted that a significant decline in fruit set, indicating their importance as visual signals to pollinators.

**Fig 2. The response of butterflies to mussaenda with bract and without bract**



Floral colour changes also serve as the visual signals for different pollinators. Rangoon creeper (*Quisqualis indica*) is an ornamental climber in which flower colour changes from white to pink then to red as the inflorescence matures. The study conducted by Yan et al. (2016) on pollinator responses to floral colour change, nectar, and scent promote reproductive fitness in *Quisqualis indica* (Combretaceae) (fig.3) shows that flowers secreted nectar continuously from the evening of anthesis until the following morning, then decreased gradually with floral colour change. The scent compounds in the three floral colour stages were similar; however, the scent composition was different, and the scent emission rate decreased from the white to red stage. Different pollinators were attracted in each floral colour stage; mainly moths at night and butterflies during the day. Observations of open-pollinated inflorescences showed that white flowers had a higher fruit set than pink or red flowers, indicating the high contribution of moths to reproductive success. He concluded that the nectar and scent secretion are related to floral colour change in *Q. indica*, in order to attract different pollinators and promote reproductive fitness.

**Fig.3. Pollinator responses to floral colour change in *Quisqualis indica* (Combretaceae)**



(Yan et al., 2016)

### Shape

In addition to color preferencing, the shape of the flower plays a large part in what specific butterfly species will visit and then ultimately frequent the flower. Large butterflies such as the Tiger Swallowtail or Monarch seek flowers with greater surface that support their body size and

weight. Other smaller butterflies, such as the Woodland Skipper or Eastern Tailed Blue can be found seeking nectar from tiny, almost inconspicuous flowers. Basic flower shape varies to some degree, but flower morphology can be a key determining factor to the attraction of butterflies.

Butterflies prefer an inflorescence (multiple flowers clustering atop a single stem) rather than a solitary flower, as the multiple inflorescence offers multiple nectar rewards. An inflorescence gives the butterfly a large pad to rest upon while feeding. Because flowers that produce an inflorescence provide butterflies with an ample nectar supply within a single location, butterfly use of these types of flowers increases and are sought out by many butterfly species. In return, because of butterfly fidelity, pollination of these flowers increase.

The study of the nectarine food plants (NFPs) available at the butterfly sanctuary of the La Union Botanical Garden (LUBG) reported that there is a interaction with butterflies acting as pollinators. total of 158 butterfly species in 8 families were identified as to their preference for specific families of NFPs. The 77 NFPs were assessed in terms of abundance, diversity, butterfly visits, nectar production and its sugar compositions. In terms of abundance, diversity and density of butterfly visits, the families Rubiaceae and Asteraceae were the most predominant NFPs as shown in table.3. This could be explained by high nectar productions in these families with sucrose being the most concentrated sugar. Among the pollinators, the families Danaidae, Nymphalidae and Papilionidae are the common denominators of all the NFPs of plants from the families Rubiaceae and Asteraceae. (Nacua *et al.*, 2014).

**Table.3. Comparison of butterfly visits, nectar production and sugar composition among 5 families of nectarine food plants**

Family	Frequency of butterfly visits per hour	Mean cumulative nectar volume (µL)	Nectar sugar concentration (% w/v)		
			Sucrose	Glucose	Fructose
Rubiaceae	98.7 ± 13.4	134.6 ± 23.2	47.3 ± 5.4	19.7 ± 3.3	13.2 ± 1.8*
Asteraceae	85.4 ± 11.2	124.9 ± 18.7	51.3 ± 6.5	15.3 ± 4.1	11.1 ± 2.1*
Verbenaceae	54.3 ± 8.8	67.4 ± 14.1	44.8 ± 4.9	15.8 ± 5.3	6.2 ± 3.2
Apocynaceae	47.9 ± 7.6	43.5 ± 8.7	41.2 ± 7.7	21.3 ± 2.7	3.8 ± 0.9
Moraceae	28.5 ± 8.1	33.2 ± 9.1	38.6 ± 8.3	20.1 ± 4.4	2.1 ± 0.7

(Nacua *et al.*, 2014)

## **Fragrance**

In addition to color and shape, fragrance is key to elicit butterfly interest and is a co-evolutionary trait that flowers and pollinators share. Butterflies have excellent sense of smell and fragrance draws them to the source. This is the reason for flowers producing fragrance. Native flowers have evolved complex relationships with their pollinators. Producing a flower is one of the most energy costing efforts a plant undergoes. Producing these complex chemical fragrance compounds that elicit the attention of passing by insects such as butterflies needs to be as effective as possible to ensure pollination occurs. Given the choice between two flowers of equal size and color, the one that is the most fragrant will be visited often.

## **Nectar and host plants**

Some plants act as host plants for caterpillars and nectar plants for adult, such plants include *Mucuna pruriens* (Naykaruna), *Passiflora subpeltata* (Poodappazham), *Ixora sp* (Thetti) and *Mussaenda sp.* (Mussaenda).

## **Alkaloid-providing plants:**

Males of some butterfly species need specific alkaloids for reproduction. These alkaloids are provided by plants like Rattle pod *Crotalaria*, Turnsole *Heliotropium*, and *Eupatorium* species. The male butterflies flock these plants in huge numbers to suck these alkaloids and is a pleasant sight to see the butterflies engrossed in the activity. They need these chemicals to synthesize sex pheromones to attract females. Developing small plots of these plants ensure flocks of butterflies especially the tiger butterflies namely, Blue Tiger (*Tirumala limniace*), Glassy Tiger (*Parantica aglea*), Dark Blue Tiger (*Tirumala septentrionis*), Plain Tiger (*Danaus chrysippus*), Striped or Common Tiger (*Danaus genutia*), Nilgiri Tiger (*Paranticanilgiriensis*) and Common Indian Crow (*Euploea core*), Brown King Crow (*Euploea klugii*). These are also called brush-footed butterflies (Kasambe, 2016).

## Plate 8. NECTAR PLANTS

### SHRUBS



*Pentas lanceolata*



*Sida rhombifolia*



*Hibiscus rosa-sinensis*



*Hydrangea macrophylla*



*Clerodendrum paniculatum*



*Lantana camara*



*Hamelia patens*



*Stachytarpheta indica*



*Salvia splendens*

### HERBACEOUS PERENNIAL



*Vinca rosea*



*Verbena bonariensis*



*Aster amellus*

### CLIMBER



*Passiflora coccinea*

## Plate 9. NECTAR PLANTS

### ANNUALS



*Zinnia elegans*´



*Dahlia* sp.



*Dianthus* sp.



*Tagetes* sp.



*Cosmos sulphureus*



*Gomphrena-globosa*

## Plate 10. HOST AND NECTAR PLANTS



*Mucuna pruriens*  
Naykaruna



*Passiflora subpeltata*  
Poodappazham



*Ixora* sp  
Thetti

## Plate 11. ALKALOID PROVIDING PLANTS



*Crotalaria retusa*



*Heliotropium*



*Eupatorium*



### **3.4. Garden adornments and accessories**

#### **3.4. a. Feeder**

Butterfly feeders can be homemade from test tubes decorated to look like flowers or hummingbird feeders. Fill the feeder with a 10:1 part sugar-water solution and plug the tube with cotton which will act as a wick and also help keep the solution from evaporating. Butterfly feeders that use a sugar-water solution are also commercially available.

#### **3.4.b. Butterfly hibernation box**

A recent addition to the butterfly garden is the butterfly hibernation box. Hibernation boxes look like elongated versions of nest boxes. They attract butterflies to yard by providing a protected space for species that overwinter as adults. Hibernation boxes are commercially available or may opt to make your own. It can build a butterfly hibernation box from a wooden container three feet high, six inches wide, and six inches deep. Cut two long 3/4-inch-wide slits in the front. Mount the box vertically on a tree or a post in a shady spot in yard.

#### **3.4.c. Butterfly house**

A butterfly house, conservatory, or lepidopterarium is a facility which is specifically intended for the breeding and display of butterflies with an emphasis on education. Place the butterfly house in garden, and when it gets cool at night the butterflies seek shelter and may use your house. By having a nectar source close by (flowers or butterfly feeder) butterflies are more likely to visit butterfly house

#### **3.4.d. Puddles and stones**

Male butterflies sometimes gather together at mud puddles. This "puddling" process is a way to sip needed amino acids and salt. Dig shallow depressions in our beds, sink a small saucer or pan, fill it with sand, dirt or small pebbles, and keep it moist and wet. Landscape also includes a generous supply of stones and flat rocks. These absorb energy from the sun, and provide a warm basking place for butterflies

### **3.4.e. Other accessories**

#### **i. Butterfly kit**

Purchasing a live butterfly kit and raise some butterflies. Once they have grown into beautiful butterflies and can release them into butterfly garden in hopes that they will make garden their home. Live butterfly kits come with everything you need to grow and raise butterflies from the caterpillar stage through metamorphosis, including the caterpillars and all of the instructions of need. Make sure that flowers and plants are the correct type that the butterflies want to attract like to feed and breed on.

#### **ii. Artificial food**

An alternative food source for butterflies is a homemade feeder filled with a solution of 4 parts water to 1 part granulated sugar. Boil the solution for several minutes until sugar is dissolved, and then let cool. Serve the solution in a shallow container with an absorbent material such as paper towels saturated with the sugar solution

## **4. Basic goals of a butterfly habitat garden**

**Strive for diversity:** The more diverse the plant, the more diverse the butterfly populations. Gardens that offer more than 20 species of flowering plants show greater numbers of butterflies occurring within those gardens

**Use mainly native plants:** Butterfly diversity increases with increasing the diversity of native plants and garden size. There is no size requirement to a butterfly garden and even a window box can count. Research shows butterfly populations and butterfly richness increase in gardens of half an acre or larger.

**Native Habitat:** Create a habitat gardens based on the habitat that previously existed there.

## **4. Ten Principles of Butterfly Gardening**

### **Principle 1**

**Grow plenty of flowers:** Most adult butterflies use flowers are their primary food source. Flowering plants are plentiful throughout the butterfly flight season as certain butterfly species occur early in the year and certain species occur late in the season.

## **Principle 2**

**Grow the right hostplants:** Many butterfly species have specific species of plants that they feed on as caterpillars. Most of these hostplants are native species and the butterflies have co-evolved with these plant species.

## **Principle 3**

**Plant a variety of plants within the garden:** Most successful habitat gardens have more than twenty different species of flowering plants, hostplants, and plants that serve as shelter and cover. The more species of plants, the garden will be more diverse.

## **Principle 4**

**No pesticides:** Even herbicides and harsh fertilizers can be harmful. Pesticides which target specific species can still have catastrophic effects on the entire garden. Natural pest control is always best and the more diverse the garden the greater the chance of balance will be achieved within the insect community.

## **Principle 5**

**Know what species of butterflies live in area:** Many butterfly species that occur regionally may not well where the garden resides. Walking through the area and making a list of what flies where is garden is helps the designer to select the exact butterfly species and the exact hostplants to lure them.

## **Principle 6**

**Provide plenty of sunshine:** Butterflies are cold blooded, they need plenty of sunshine and warmth to carry out their basic life processes. Creating pockets of warmth through windbreaks and shelter can encourage butterflies to use and perhaps stay within the garden. Open spaces or basking stones help butterflies get warm and stay warm.

## **Principle 7**

**Arrange plants strategically:** Massing flowering plants encourages butterflies to find and then stay within the space. Spreading the hostplants out encourages the butterflies to disperse their eggs and caterpillars so predators can't find them in one easy place.

## **Principle 8**

**Provide water and minerals:** Butterflies, especially males use wet patches of earth to hydrate and gain precious minerals for reproduction. Providing puddling stations helps address this vital stage in butterfly life cycle needs.

## **Principle 9**

**Let the garden be wild:** This need for leaves to remain in planting beds and grass to be left unmowed and shrubs to be untrimmed is vital, as many hibernating butterflies in the adult, chrysalis, egg, and caterpillar stages will often be hiding within these unkempt areas during winter

## **Principle 10**

**Experiment:** All well laid design plans may not result in successfully encouraging butterflies to visit or live within your garden. Each microclimate that is created within the garden may take considerable experimentation to achieve desired results

## **6. Butterfly garden designing**

Designing of urban butterfly habitat gardens based on the life histories of the butterflies. These life histories are the butterfly life cycle, the butterfly needs and the butterfly behaviors. Garden size, native hostplant selection and diverse and ample nectar source availability become interdependent factors on successful butterfly habitat gardening. Thus, the garden design should focus on the butterfly life histories as well as the specific plant selections to meet butterfly survival requirements.

### **6.1. Steps of butterfly garden design**

1. Conduct a butterfly survey
2. Select location
3. Fixing position of plant - nectar & Host source and position for butterfly activities
4. Sketch the plan

#### **6.1.a Conduct a butterfly survey**

Even with the information of butterfly to habitat occurrence, direct observation is a vital step to confirming the presence of potential butterflies on or near site. Visiting local parks and walking neighborhood gardens not only confirms which butterflies are commonly found within the area, but how these insects are interacting within their environment is vital information for design decision making. Description of butterfly should be made by observing their abundance, habitat, host plants, nectar plants, larval behaviour and adult behaviour.

### **6.1.b. Select location**

Butterfly garden can be a closed one or an open one. (Kasambe, 2016)

**Closed butterfly garden:** A closed butterfly garden can be an entire garden covered with green nets. The butterflies are released into this enclosed area either as adult butterflies or are reared in the garden itself. In Singapore and London butterfly parks, they procure pupa (chrysalis) and keep them in small boxes till the butterflies emerge. As soon as the butterflies emerge they are released into the garden. In absence of any predators, the butterflies survive till they die naturally.

But the Indian Wildlife Protection Act (1972) considers butterflies as wild animals and it is illegal to keep any wild animal in an enclosure (or captivity, in the legal language). As soon as there is an enclosure, it becomes a zoo. And to run a zoo, permission is required from Central Zoo Authority of India and also it is mandatory to follow their guidelines for establishing and managing a zoo.

Hence, the only and best option is to set up an '**Open butterfly garden**' on your own or leased land. Here the butterflies are free ranging and no butterfly is captured or captive.

#### **i. Landscaping for butterfly garden**

To set up a new butterfly garden, need a suitable piece of land at the right location, man power, working knowledge of landscaping, good knowledge about butterflies and their requirements, knowledge about plants and finances to run the garden.

It is important to have a good location for the butterfly garden, especially the open butterfly garden. The best location will be near a patch of forest, as the butterflies can be attracted to the garden by fulfilling the necessary requirements. The butterfly habitat that the garden represents should resemble the habitat that existed on the site before the landscape. An ideal butterfly garden is nothing but a miniature representation of the forest in the adjoining area where various plants and flowers are grown. The environment is made as conducive as possible for butterflies found in the area.

A butterfly garden can be any size. It is not necessary to have big plot to attract butterflies to the garden, even a small plot can be converted into a good butterfly garden. It is better to avoid setting up a new butterfly garden in very dry areas or very cold areas, deserts, and in highly urbanized areas with not many butterfly species around. A butterfly garden can be large area or

small as the size of a window box. Sankaranarayanan (2018) studied on the effects of garden size in relation to butterfly diversity and in fact the larger the butterfly garden, the greater the butterfly diversity and the greater the butterfly abundance. Butterfly garden size matters less in lesser urbanized areas where access to wild spaces remains high. However, where urbanization is more intense, larger garden spaces significantly increases butterfly species richness (Fontaine, 2016). Studies that have researched butterfly diversity within urbanized areas have found that larger gardens within urbanized areas of ½ an acre or larger have the highest potential to support a greater amount of butterfly species than smaller gardens (Mauro 2007). Research also shows that gardens which grow 20 or more flowering plants, demonstrate the greatest amount of butterfly diversity (Mauro 2007).

## **ii. Pre requisites of location**

Butterfly garden should be in a sunny, open area protected from wind. Determine from which direction the prevailing wind comes, and plant larger shrubs, vines, or trees as a windbreak. The windbreak should protect from wind without decreasing the amount of sunlight. Landscaping should be in such way that there are places which provide shade, lot of sunshine, and wet patches too.

- **Sunlight**

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 the morning. They become active after basking in sunlight for some time. Hence the garden should have lot of flower beds with lot of sunlight getting at least 6-hours per day. If the garden is very big, the trees can be planted along the eastern edge or they should be planted along the western edge or forming a line running north-south in the middle of the garden to get maximum open space.

- **Water**

Butterflies need, not only nectar from flowers, water as well. Often on warm afternoons, butterflies will congregate at the edges of streams, ponds, or wet patches of ground to sip water from the earth. Puddling, mainly a male butterfly behavior, has more motivations than the attainment of water for hydrating their bodies. The puddle station should receive a constant supply of fresh water, be it from irrigation or a natural source.

- **Shelter**

A fundamental need of butterfly survival is shelter. Because butterflies are small and fragile, they can succumb to the elements of heat and cold, wind and rain quite easily. In addition, butterflies seek shelter to avoid being found by predators. Analyzing the individual components of the need for shelter can lead to design decisions within the garden that can better provide for butterfly survival.

**Shelter from wind**

An understanding of seasonal wind direction can inform design decisions within the garden. Since butterflies reduce their activity during wind events, creating sheltering buffers and microclimates is important. Vegetation can serve both as habitat and wind buffering elements. Massing plants together that form thick matrices of leaves and branches can provide an effective wind buffer, creating a calmer microclimate and promoting butterfly activity.

**Shelter from rain:**

Inclement weather in the form of rain can pose a serious threat of injury or death to a butterfly that weighs less than a gram. This vegetation can take the form of tall grasses, woody thickets, perennial herbaceous plants, rock overhangs, or even against man-made structures. Tree canopies slow down rain drop velocity, buffering butterflies from large quantities of rain.

**Shelter from heat:**

As much as butterflies are dependent upon heat for flight, too much heat can be dangerous. During flight, a butterfly builds up heat through friction of moving its flight muscles back and forth. If temperatures begin to rise above 100 °F, butterflies run the risk of overheating. Deciduous trees are a valuable design component, in that block solar radiation in the spring and summer, when temperatures rise and allow for solar radiation to reach and warm the ground in fall and winter. During the warm months the tree canopy can cool ambient temperatures by 15°F

**6.1.c. Fixing position of plant - nectar & Host source , position for butterfly activities and other need of garden**

**i. Fixing position of plant - nectar & Host source**

- Combine with sunlight need
- Consideration for wind protection
- Configuration of spatial nectaries
- Consideration for flower species

- Consideration for habitats
- Consideration for flower color
- Consideration for bloom time
- Consideration for vegetation structure

**ii. Fixing position for butterfly activities**

- Combine with sunlight need
- Consideration for wind protection
- Combine with reproduction need
- Consider hostplant association
- Consideration of vegetation structure
- Consideration of perching species, patrolling species, puddling species
- Consideration for activity in a time of day
- Consideration of habitats
- Consideration for water depth for puddling
- Consideration of basking behavior

**iii. Maintaining a Genetic Stock and nursery of plants**

It is important to maintain a genetic stock of all the larval host plants and nectar plants in the form of seeds or grafts. The seeds should be collected whenever they are found and kept safe till the pre-monsoon period. The seeds should be grown in a netted nursery and then shifted to the butterfly garden. This should be done at least to plant species *Tagala* and *Aristolochia* as the caterpillars of Roses are known to finish the entire plants leaving nothing behind.

**iv. Maintaining a butterfly house**

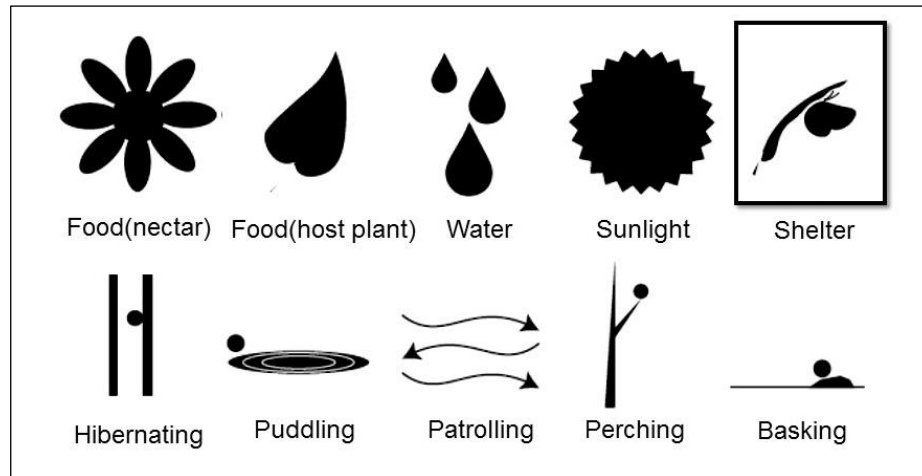
Butterfly can be rear in house by searching for caterpillars on larval host plants of butterflies like Lime tree *Citrus* spp. or Curry Leaf tree *Murraya koenigii* may have caterpillars of Common Mormon *Papilio polytes* and Lime Butterflies *Papilio demoleus*. Pick that caterpillar and bring with it a stock of tender leaves to feed it on. Keep it in a transparent box. Keep some sticks in the box for the caterpillar to pupate. Clean the box every day for the excreta. The caterpillar will get converted to a pupa one day later it will emerge as beautiful butterfly.



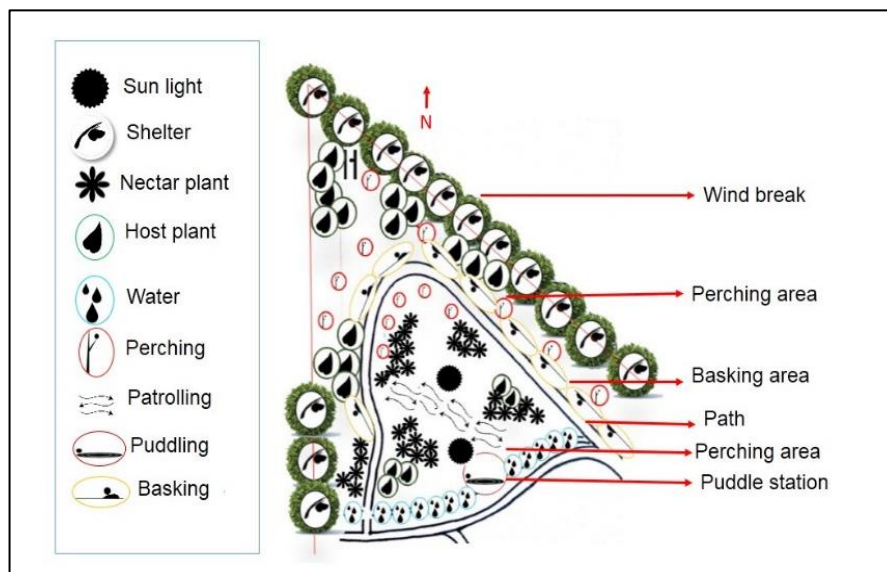
### 6.1.d. Sketch the plan

For sketching the layout of garden, in addition to landscaping symbols some other symbols are exclusively used for making butterfly garden plan which shown in Plate no. 12. A system of selecting symbol icons and plugging them into the design for indicating various garden requirements will ensures a simplistic approach for making a final plan of butterfly garden as shown in Plate no.13.

**Plate 12. Symbols used for designing butterfly garden** (Hawthorn, 2018)



**Plate 13. Final plan**



## 7. Butterfly gardening for limited space

### i. Container butterfly garden

Materials needed:

- Variety of containers
- Plastic garbage bags
- Scissors
- Potting soil (moistened)
- Butterfly-attracting flowers (plants and/or seeds)
- Sphagnum moss



Steps for making container garden

1. Start with a container.
2. Place broken pieces of clay pots on the bottom of the container for drainage
3. The container needs a variety of soils
4. Mix equal parts of the soils well and add water to moisten.
5. Plant tallest plant such as *Salvia*, milkweed, dill or fennel in the middle of the container for height.
6. Place seeds or plants around the inside edge of the container where shorter flowers to grow.
7. Place the container in an area to receive sun or part-shade and wind protection.

### ii. Butterfly garden in Roof top

Green roofs or roof gardens are gaining more and more popularity as their environmental benefits are being recognized, reducing water run off and as a natural building insulator. Roof gardens have the potential to provide resources for urban wildlife populations primarily for birds and butterflies.



## 8. Psychological benefits of butterfly garden

Butterfly gardening a delightful hobby for gardeners, open a whole new world to special populations. Scientific research is supporting long held belief that horticultural activities offers physical, emotional, intellectual, social benefits to people of all ages and from all walks of life. As therapy, horticultural activities are used as treatment programs with defined goals for patients.

As job training, they are used to teach general as well as specialized job skills. In a less formal setting, they can be used as recreational programs in nursing homes or senior citizens centers. Butterfly gardening is an effective channel for attracting people to horticulture.

**i. For patients:** Horticultural activities help many patients recovering from brain injuries relearn living skills and accept responsibility for their actions and achievements, thus rebuilding self-confidence and independence. They become care-givers rather than care recipients. Their success in caring for the plants helps build self-esteem and gives them back some control in their lives.

**ii. For old ages:** Butterfly Gardening should have particular appeal for senior citizens, who enjoy gardening and nature. In recent years there has been a dearth of butterflies, especially in urban areas, and many older people have recalled youthful memories of butterflies dancing in meadows. One of gardening's great benefits for the elderly is that it evokes happy memories of the past. For many older residents in nursing homes or residential centers, there is little to look forward to. Gardeners are full of anticipation, waiting for that seed to sprout, that plant to flower or bear fruit, or the new spring foliage to burst out. Butterfly gardening is even more exciting, with the additional magic of the butterfly's metamorphosis.

**iii. For school children's:** School butterfly gardens have exploded in popularity over the past decade especially in schools. A number of schools, particularly elementary schools, are installing butterfly gardens on their grounds. The school butterfly garden changes learning by involving students in actions that directly affect an environment for which they feel responsible. While the garden itself provides a rich theme for integrated academic study, the benefits of working in the garden go beyond academics to touch the hearts and spirits of future citizens.

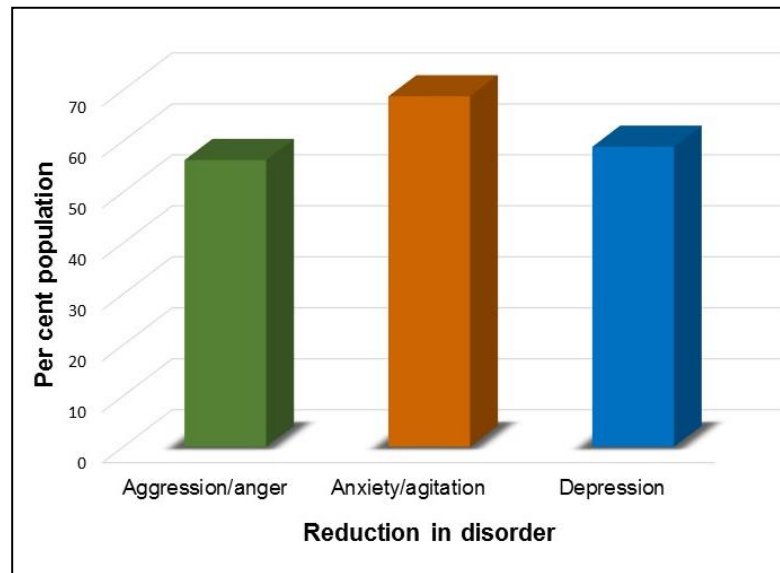
Natural environments have healing effects for most people, as investigated and proven in numerous studies. A natural environment can alleviate depression, anxiety, and stress. A pilot study conducted by Liao *et al.* (2018) aimed to understand the benefits that natural environments, such as gardens, can provide for people with dementia (Fig.4). Among the evaluated behavioral problems, staff members reported that garden visits reduced dementia residents' depression, anxiety/agitation, and aggression/anger.

In total, 7.84% and 58.85% of participants reported that natural elements in the gardens, such as fresh air, sunshine, and plants, reduced residents' depression. Their stress was relieved in the gardens. Residents could enter and leave the garden or courtyard independently, which

provided a sense of independence, reducing depression. The garden visits made the residents happier.

In total, 68.75% of participants reported that garden visits improved residents' anxiety or agitation. In total, 56.25% of participants reported that garden visits reduced residents' aggression and anger levels. The fresh air and agreeable weather were therapeutic, and the positive ambience of the gardens cheered residents.

**Fig.4. Effects of garden visits on people with dementia**



## 9. Butterfly Conservation

Butterfly populations are declining worldwide primarily due to Urbanization and the disappearance of habitat. The practice of clearing native vegetation and replacing it with exotic plants forces many urban butterflies. In addition to this pesticide application, pest and disease incidence, climate change are the reason for extinction of butterflies. Today, butterflies are becoming increasingly scarce, with many endangered and some actually extinct. So great has been the decline in the number of monarchs in the last two decades (90% in recent years).

Butterfly populations face many challenges, none so great as the loss of habitat due to urbanization. Due to loss of habitat (caused by modern agricultural and forestry practices, development and cropland conversion) and consequently, the loss of food sources provided there.

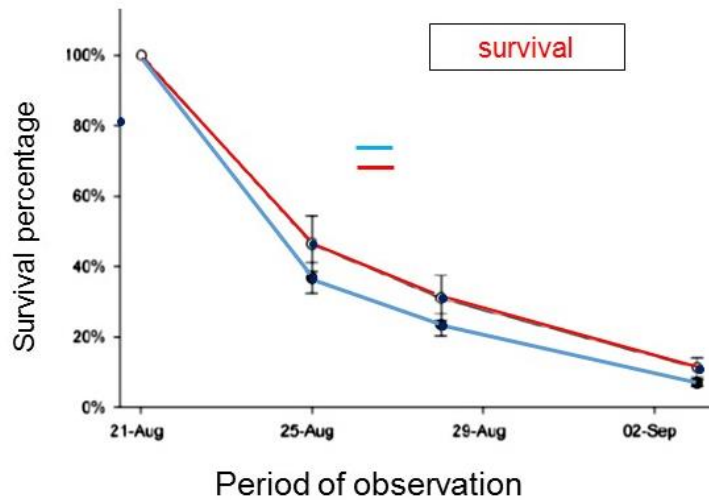
As human disturbance (urbanization) increases, changes in landscape and vegetation matrices often create flight obstacles and decrease butterfly population movement (Singer 1991). An urban butterfly garden can contribute to an ever-growing awareness of the need to provide wildlife a place of refuge. As urbanization continues to push further into wild spaces, butterfly gardens can provide vital habitat for declining butterfly populations (Fontaine 2016). This habitat loss can be mitigated by strategically planning and designing butterfly gardens.

In areas where wide spread urbanization has occurred, urban gardens are now recognized for their role in supporting wildlife. In England, gardens are now considered their “most important nature reserve”, where cultivated spaces planted with both native and ornamental plant species fill the void where habitat has been lost (Shackleton 2016).

**An evaluation of butterfly gardens for restoring habitat for the monarch butterfly (Lepidoptera:Danaiidae).** (Cutting and Tallamy, 2015).

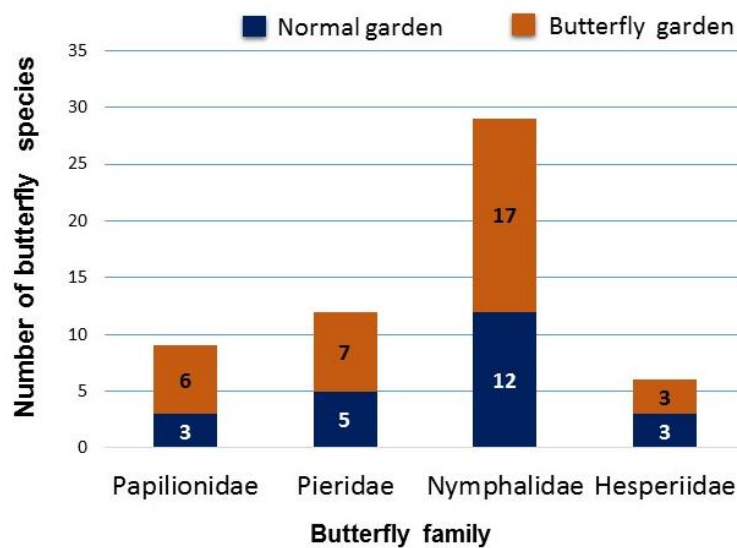
The eastern migratory monarch butterfly (*Danaus plexippus* L.) population in North America hit record low numbers during the 2013–2014 overwintering season, prompting pleas by scientists and conservation groups to plant the butterfly’s milkweed host plants (*Asclepias* spp.) in residential areas. While planting butterfly gardens with host plants seems like an intuitive action, no previous study has directly compared larval survival in gardens and natural areas to demonstrate that gardens are suitable habitats for Lepidoptera. In this study, milkweed was planted in residential gardens and natural areas. In 2009 and 2010, plants were monitored for oviposition by monarch butterflies and survival of monarch eggs and caterpillars. (Fig. 5) Monarchs oviposited significantly more frequently in gardens than in natural sites, with 2.0 and 6.2 times more eggs per plant per observation in 2009 and 2010, respectively. These results suggest that planting gardens with suitable larval host plants can be an effective tool for restoring habitat for monarch butterflies. If planted over a large area, garden plantings may be useful as a partial mitigation for dramatic loss of monarch habitat in agricultural settings.

**Fig.5. Survival percentage of butterflies in natural habitat and butterfly garden**



Comparative study conducted by Thakur *et al.*, 2017. on butterfly population in an unmanaged garden and managed garden of the Lady Brabourne College, Kolkata campus (Fig.6.) shows that previously total 31 species of butterfly visited in un managed garden. Observation in managed garden clearly indicate that total 43 species of butterflies were recorded in the garden including 9 species, which were not seen un managed garden and with 8 species completing their life cycles.

**Fig .6. Species richness of butterflies in normal garden and butterfly garden**



## **10.1. Butterfly Gardening in World**

Butterfly gardening is believed to have begun in England in the 1970s, as an expression of the British love of gardening and nature; the Butterfly World habitat was inaugurated at Coconut Creek in Florida, in the USA, in 1988.

Other famous butterfly conservatories are

1. Niagara Parks Butterfly Conservatory in Niagara Falls, Ontario, Canada.
2. Victoria Butterfly Gardens, Canada.
3. Dubai butterfly garden
4. Singapore Changi Airport Butterfly Garden
5. Lyons Tradewinds Park, Coconut Creek

## **10.2. Butterfly Gardening in India**

In last few years there has been a tremendous increase in the interest in developing butterfly gardens (parks) in India. Many private as well as government butterfly gardens are coming up at various places across India. It is a good sign, in the sense we have started appreciating the importance of butterflies as objects of aesthetic value, for conservation as well as to create sustainable livelihood options for many.

1. Butterfly Park (enclosure), Ramoji Film City, Hyderabad, Andhra Pradesh
2. Butterfly Conservatory of Goa, Ponda, Goa.
3. Sammilan Shetty's Butterfly Park, Santhadi House, Butterfly Park Road, Belvai Village, Mangalore, Karnataka
4. NPCIL plant site, Kaiga, Karnataka.
5. Butterfly Garden, Bhanerghatta, Bannerghatta National Park, Bengaluru, Karnataka

## **10.3. Butterfly Gardening in Kerala**

1. Butterfliesafari, Thenmala, district Kollam, Kerala
2. Butterfly Park at Nilambur Teak Museum, Malappuram, Kerala
3. Sálím Ali Bird Sanctuary, Thattekad, Kerala
4. Thumboormuzhy, Peechi KFRI & ShakthanThamburan Museum, district Thrissur, Kerala.
5. Nilamboor KFRI sub-center, district Malapuram, Kerala
6. Thattekad Bird Sanctuary, district Ernakulam, Kerala.

## Plate no.14. BUTTERFLY GARDENS

### WORLD FAMOUS BUTTERFLY GARDENS



Dubai butterfly garden



Singapore Changi Airport  
Butterfly Garden



Butterfly World  
Lyons Tradedwinds Park,  
Coconut Creek

### FAMOUS BUTTERFLY GARDENS IN INDIA



Butterfly Park, Bengaluru



Ovalekar Wadi Butterfly  
Garden, Thane, Mumbai



Butterfly Conservatory,  
Ponda



Butterfly Park, Chandigarh



Butterfly Park (enclosure), Ramoji Film City,  
Hyderabad, Andhra Pradesh



## Plate. 15. BUTTERFLY GARDENS

### FAMOUS BUTTERFLY GARDENS IN KERALA



Butterfly Safari  
Thenmala



Butterfly garden in  
Salim Ali Bird Sanctuary, Thattakad, Kerala



Thumboormuzhi butterfly park



Butterfly park, Kerala university

### KFRI Butterfly gardens



Peechi



Nilambur

### BUTTERFLY GARDEN AT COH, VELLANIKKARA



## **11. Future prospects**

In India, we can have small closed butterfly gardens in major zoos and at major International Airports for recreation. Promote the establishment of butterfly garden in schools, hospitals and other public areas. For maintaining these gardens, we can start rearing butterflies of belonging to the commoner but beautiful and colourful species, not necessarily rare or those protected under various Schedules of the Indian Wildlife Protection Act (1972), with the help of tribal communities and create thousands of jobs. Research should be under taken for identifying more number of native host plant and nectar plants species for accommodating colourful butterfly species in gardens.

## **12. Conclusion**

Walking through the Butterfly Garden is an invigorating and calming experience. Mixture of larval host plants, nectar resources and alternative foods like fruit, welcome a diversity of winged life into the garden. Butterflies maintain the ecosystem by acting as pollinator, prey, biological pest control and enhance environmental beauty. Hence greater emphasis should be placed on management of habitat and better integration of protected areas for butterflies.

## **13. Discussion**

- How climate change decline population of butterflies?

The iconic and beloved North American monarch butterfly is one of the species that has difficulty adjusting to our new climate-stressed world. Its population has declined 95 percent in the last 20 years because of high temperature, loss of milk weed plants due to increasing concentration of carbon di oxide

- Pest and diseases of butterflies?

The best-studied monarch parasitoid is the tachnid fly *Lespesia archippivora* (*La*), which attacks larvae, resulting in the death of late-instar larvae or pupae. Research in the Monarch Lab suggests that this species is the most important monarch tachinid parasitoid.

Many parasites and disease-causing pathogens are known to attack insects, including viruses, bacteria, fungi, protozoans, nematodes, and mites. Several viral and bacterial pathogens can infect monarchs, including a nuclear polyhedrosis virus and *Pseudomonas* bacteria

- Without host plants, how do these caterpillars survive?

Without the host plant, we can also rear caterpillars by providing artificial food such as sugar syrup in 1:4 ratio.

- Butterfly population is more in natural habitat than well-maintained plantation. Why?

An ideal butterfly garden is nothing but a miniature representation of the forest in the adjoining area where various plants and flowers are grown. Training and pruning are not much recommended in a butterfly garden because it will destroy the larvae and pupae of several butterfly species. The environment should be made as conducive as possible for butterflies found in the area.

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## 15. Abstract

**KERALA AGRICULTURAL UNIVERSITY  
COLLEGE OF HORTICULTURE, VELLANIKKARA  
Department of Floriculture and Landscaping  
FLA 591 : Master's Seminar**

Name	: Rashidha. C.K	Venue	: Seminar Hall
Admission No	: 2018-12-011	Date	: 22-11-2019
Major Advisor	: Dr. Mini Sankar	Time	: 10. 45 am

### **Butterfly gardening: Landscaping for aesthetics and butterfly conservation**

#### **Abstract**

Butterflies are the most fascinating creatures existing on earth and have great aesthetic value. From ecological standpoint, they are indicators of biodiversity and environmental health. They procure nectar from flowering plants and serve as the pollinators of various plant species. Attracting this fascinating insects to the garden can add an ever changing mural colour and motion to the landscape.

A butterfly garden is a specifically planned space to attract and keep butterflies supplied with the basic elements that they need for their survival *viz.*, food, sunlight, water and shelter. Butterfly gardening is a delightful hobby and offers physical, emotional, intellectual and social benefits to people who engaged in it. Liao *et al.* (2018) reported that garden visits had positive effects on mood and social interaction in people with dementia because of the multisensory gentle stimuli of natural environment.

A butterfly garden consists of components such as butterflies, host plants, nectar plants, garden adornments as well as area for specific butterfly activities *viz.*, puddling, perching,

patrolling and basking. Host plants are the plants on which butterflies lay eggs and the emerging caterpillars feed on parts of plants. The major host plants include *Cassia fistula*, *Polyalthia longifolia*, *Michelia champaca*, *Aristolochia indica* etc. Native host plants also play a vital role in attracting butterflies and increasing the diversity of butterflies. Gideon *et al.* (2016) studied the native plant species of the Eastern Ghats region and reported that *Vitex negundo* had maximum butterfly visits. Nectar plants provide nectar and sustain adult butterflies. The major nectar plants include *Pentas lanceolata*, *Ixora* sp., *Tagetes* sp., *Lantana camara* etc. Garden adornments are the items which attract the butterflies and enhance the beauty of garden. Butterfly house, feeders and hibernating boxes are commonly used in butterfly garden to enrich the aesthetic value. Butterfly garden designing strategies are based on the life cycle of butterflies, their needs and behaviours. A system of selecting icons and plugging them into the design at various stages ensures a simplistic but comprehensive approach for building butterfly garden.

Butterflies are often considered as opportunistic foragers that visit a wide variety of host plants and nectar plants. The choice of plants as nectar sources by butterflies depends on innate colour preference, corolla depth and clustering of flowers. Floral colour changes also serve as the visual signals for different pollinators. Rangoon creeper (*Quisqualis indica*) is an ornamental climber in which flower colour changes from white to pink then to red as the inflorescence matures. Yan *et al.* (2016) observed that white flower in early stages of flower opening in Rangoon creeper attracted moths, whereas butterflies are attracted to red flowers. In terms of frequency of butterfly visits, the plants belonging to the families Rubiaceae and Asteraceae were found to be the predominant nectarine food sources due to high nectar production with higher content of sucrose (Nacua *et al.*, 2014).

Today butterfly populations are declining worldwide primarily due to loss of habitat. Cutting and Tallamy (2015) compared survival percentage of monarch butterflies (*Danaus plexippus* L.) in milk weed (*Asclepias* spp.) under two habitats *viz.*, in natural areas as well as in gardens and observed a higher survival percentage of butterflies in gardens rather than in natural areas. Establishment of butterfly garden helps to increase butterfly diversity and abundance in urban as well as in suburban areas and conserving species that might otherwise become rare or even disappear.

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