



Special Ecology Feature

Creating Butterfly Habitats and Gardens to Enhance Urban Biodiversity

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LEFT A locally extinct butterfly species—Clipper (*Parthenos sylvia*).

ABOVE A Painted Jezebel (*Delias hyparete*) butterfly nearing its end.

Introduction

Butterflies occur in most natural habitats on the terrestrial terrain. From the dense forest, open country, mangrove, and so forth, to the urban habitat, there are numerous species that inhabit these environments. There were over 400 butterfly species recorded in Singapore, but due to urbanisation, industrialisation, land clearance, and development, their natural habitats are fast disappearing and being taken over by the ever-expanding concrete jungle.

The tropics are well known for their high plant and animal biodiversity and Singapore enjoys a rich biodiversity index in this geographical region. However, over a third of these species are locally extinct due to environmental destruction and pollution. The extinction rate of native floral and faunal species is a cause for concern. Once these natural habitats are destroyed, it is difficult and challenging to recreate a balanced and sustaining ecosystem in the urban jungle with fragmented pockets of greenery.

In Singapore, there are numerous butterfly themed parks and gardens, but few are directly involved in its conservation and breeding. Hence, the Butterfly Garden at HortPark was conceived and opened in May 2009 to create an awareness of butterfly habitat and biodiversity conservation, and various extant butterfly species were bred and released through the Butterfly Species Recovery Programme to newly constructed or existing habitats to boost their wild populations. In fact, back in December 2007 when the park was first opened to the public, it was already heavily planted with numerous host and nectar plants in various theme gardens to support existing populations of urban butterflies.

Importance of Butterflies

Butterflies, like some other faunal groups such as frogs, are excellent environmental and plant biodiversity indicators as they rapidly go into decline when there is severe environmental destruction and pollution. So, their continued presence is indicative of a healthy thriving environment whilst their absence and disappearance points to a degrading environment that is in demise. Similarly their disappearance is an allusion to the loss of and extinction of plant species brought about by development and habitat destruction.

Angiosperms are a group of flowering plants that dominate the terrestrial ecosystem and account for about 80 percent of all vascular plant species on earth. Like bees, butterflies are important pollinators of these flowering plants. Without pollination, these plants would not be able to produce fruits or set seeds through sexual reproduction. Animals that have a staple diet of these fruits for food would be the first to suffer from the disappearance of butterflies.

This process of sexual reproduction in plants through seeds, as opposed to asexual propagation of plants (e.g., cuttings, marcotting, and division), is also essential and critical to increase the gene pool of plants and create diversity and variation amongst plants. Sexual reproduction plays a very important part in giving rise to the natural plant varieties and hybrids in the wild. Without butterflies, some of these plants that are heavily reliant and dependent on butterflies for pollination would not be able to produce fruits and viable seeds that can be dispersed over long distances to help the plants extend their areas of colonisation.



ABOVE Leopard Lacewing (*Cethosia cyane*) caterpillars feeding on *Passiflora foetida*.



ABOVE Mottled Emigrants (*Catopsilia pyranthe*) and Lime Butterfly (*Papilio demoleus*) puddling on the ground.

Understanding Butterflies

The life span of a butterfly is relatively short at around one to two months from its egg stage to the adult butterfly stage. The four life stages of a butterfly are (1) egg, (2) larva [caterpillar], (3) pupa [chrysalis], and (4) adult butterfly.

The association and evolutionary relationship between butterflies and their host plants is very intricate, to the extent that a butterfly species has very specific plant food requirements for its caterpillars. There is a limited range of host plants that the mated adult female actively seeks out to lay her eggs. Upon hatching from the egg, the caterpillar is a feeding machine that spends its entire time eating the leaves of its host plant to build its body mass before morphing into a seemingly dormant pupal stage. Within the pupa case, complex metabolic, bio-chemical reactions take place to physically transform it into a butterfly. As soon as the butterfly emerges from its pupa case and is able to take flight, the amorous butterfly spends the rest of its short life seeking a mate, mating and laying eggs, whilst intermittently feeding on the flowers of nectar plants or other sources such as decomposing fruits and animal carcasses to sustain itself, until it comes to the end of its life span. The cycle then begins again.

In the natural environment, butterflies have a range of food sources to feed on, for example, flowers, animal carcasses, and decomposing fruits. For an artificially created garden landscape, there are limited food sources, and it is absolutely essential to plant up a wide variety of flowering plants that will serve to provide nectar to the butterflies. In the urban landscape and gardens, some common garden weeds or parasitic plants, such as mistletoe on trees, are also the hosts and nectar plants of some of the beautiful butterflies.

In nature, the eggs and larvae of butterflies may also be parasitised by some wasp and fly species. Such parasitisation may account for up to 80 percent of mortalities in butterflies.

So for a butterfly species to be able to successfully breed and have a healthy sustainable population, it is pertinent for the host plants to

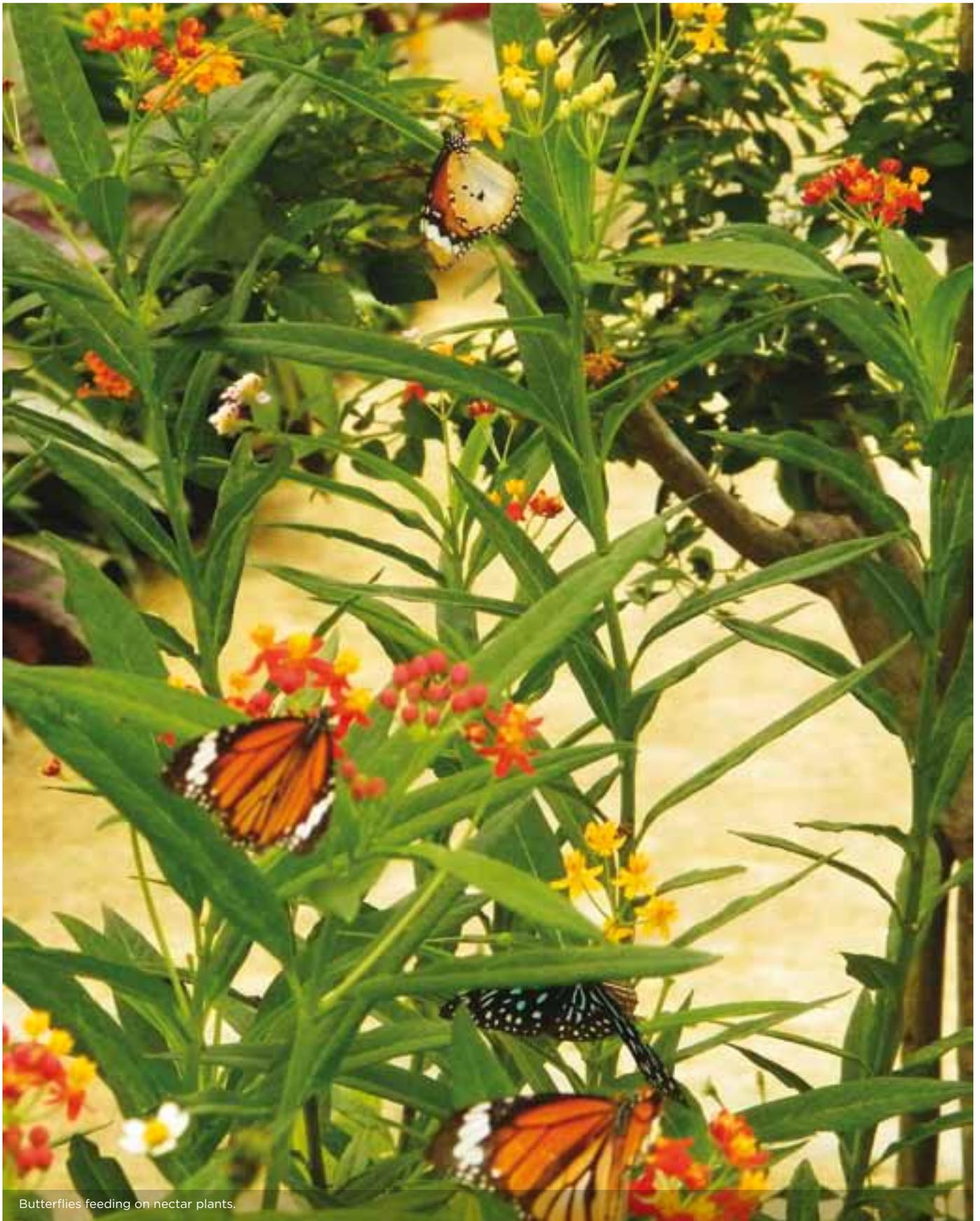
be present in large quantities and in more widespread areas over a larger geographical distribution to increase their chances of survival and reduce the impacts of sudden or localised environmental changes, parasitism, habitat destruction, and so forth, which affect their survival and mortality.

Design Considerations

In the planning and creation of a butterfly friendly habitat in any new development sites or existing gardens, it is absolutely essential to take into consideration both the hardscape and softscape elements. A well planned and designed garden is coherent and seamlessly integrated to promote ecological balance, long-term environmental sustainability, and habitat and biodiversity conservation.

In the strictest sense, a butterfly garden setting that successfully attracts butterflies to arrive and breed in it is more often than not informal, random, and natural in its plant design and layout and has a wider range of plant species. This garden usually has more imperfections—be it a weed here and there, a plant that is out of place, or plants that are pest-infested, and so forth. However, this garden is more ecologically balanced, respects the close and interdependent interaction between its plants and animals, and is likely to be more successful in supporting a high biodiversity of fauna. On the other hand, a formal, well-manicured, weed-free garden is not as ideal and conducive for butterflies not because of its low plant species diversity but high dependence on aesthetics, order, pesticide application, frequent pruning, low tolerance for weeds, so on and so forth. Nevertheless, it is not entirely impossible to create a formal garden that is butterfly-friendly through a good design and layout, suitable choice of plants, and appropriate maintenance.

The location of a butterfly garden or trail should ideally be sited away from extensively built-up infrastructures and hardscape elements, such as vehicular roads, tracks and busy walkways with high pedestrian volume and pollutive elements, among others. The presence of natural green corridors and elements are preferred and are most suitable to lure the butterflies from neighbouring habitats.



Butterflies feeding on nectar plants.



LEFT TO RIGHT A Plain Tiger (*Danaus chrysippus*) feeding on the flowers of *Asclepias curassavica*; a Green Baron (*Euthalia adonia*) butterfly on *Cestrum diurnum*.

For a development site that is originally a natural habitat (e.g., forested areas and mangroves) or is close to one, it is most ideal to make use of this proximity. The likelihood of attracting the native butterfly species from the habitat to the site is higher with the retention of whole parcels or pockets of host and nectar plants and incorporation of these plants into the overall design and landscape of the site. It is pertinent to mimic and recreate an environment that is as close to its original state and condition as possible for the longer-term sustainability of the butterfly species at the developed site. This helps to attract the butterfly species to arrive, feed, reside, and breed within the locality.

On the other hand, for an urban environment that is detached from any remnants of a natural habitat, it is best to design and landscape the surroundings with host plants of urban butterfly species, such as Lime Butterfly and Common Grass Yellow, that are more adaptable to an artificial setting. Attempts to plant up such an environment to attract butterfly species from other habitats, for instance, a forested area, are not feasible and are likely to be futile.

It was observed that butterflies seem to prefer their host and nectar plants to be spread out over an area and not confined together in a single locality or area. Ecologically, this makes sense because this allows the butterfly population to be distributed over a larger area, and any sudden, adverse biotic or abiotic effect, such as land clearance and fumigation, may wipe out the butterflies and their young in a localised area but not at other areas. This helps to ensure the survival of the butterfly species.

In a project that emphasises landscape aesthetics as a key consideration factor, it is more practical and prudent to plant host plants in the landscape background or at obscure corners to avoid showcasing caterpillar-ridden or severely devoured plants. Attractive and appropriate nectar plants are best planted along walkways and paths to provide better sightings of feeding butterflies that flit from flower to flower.

Maintaining a Butterfly Garden

Having selected and planted up a development site or existing garden with the appropriate host and nectar plants, it is very important to exclude the usage of inorganic pesticides, other pollutive chemicals, elements, and activities, like fogging for mosquito prevention, in the landscape to create a chemical free, butterfly friendly environment. As butterflies and their young are very sensitive to such chemicals, their usage usually spells doom to these creatures. Surroundings with known pollutive elements such as roads should preferably be screened off with a thick buffer of lush green plants to prevent and minimise the permeation of these harmful substances to the environment and their detrimental effect on the butterflies and their young.

If any inorganic pesticides or chemical substances need to be used in the environment, it would be best to target and directly treat only the non-butterfly host and nectar plants, surfaces, or items that the products are to be used on.

Special attention must be paid to the weeding of a butterfly garden. Some unattractive but common garden weeds (e.g., *Cleome rutidosperma*) and some parasitic plants on trees and shrubs (e.g., *Dendrophthoe pentandra*) are the host plants of some butterfly species. In an ideal garden setting that supports butterflies, such weeds and parasitic plants should not be removed completely. If at all, some pruning or removal can be done to control the spread and growth of these weeds and parasitic plants.

The HortPark Story

In the planting up of HortPark prior to its opening, clusters of its host and nectar plants were unknowingly planted throughout the whole park in various theme gardens such as the Floral Walk, Carpark Garden, Silver Garden, and Golden Garden. These plants included for example, *Asclepias curassavica*, *Calliandra emarginata*, *Caesalpinia pulcherrima*, *Lantana camara*, *Pseuderanthemum* cultivars, *Stachytarpheta indica*, *Calotropis gigantea*, *Crotalaria retusa*, and *Flacourtia*

inermis. As a result of this, the widespread planting of these plants in small groupings distributed in pockets over short distances provided a natural corridor for some butterflies such as the Common Grass Yellow, Autumn Leaf, and Leopard to travel along and the butterfly sightings in the park were fairly common.

With the Butterfly Garden project in 2009, a 100-square-metre enclosure with an adjacent outdoor garden was constructed for research purposes to house up to 20 species of native and non-native butterflies in an attempt to create awareness of environmental and ecosystem sustainability and conservation and to carry out in-house breeding of these butterflies to gain a more in-depth understanding of their life cycles, feeding behavior, breeding requirements, host and nectar plants associations, and so on. A separate breeding facility with breeding containers, housed in a different area, allowed the study of their complete development from eggs, caterpillars, pupae, to butterflies to be documented.

In addition, with a better understanding of butterflies from the project, small populations of the Plain Tiger butterflies were introduced to the park. The presence of its host plants in the park actually facilitated its natural breeding as caterpillars were found on all clusters of plants at various parts of the park.

In a separate trial, the proximity to the densely forested Kent Ridge Park was taken advantage of. Pockets of *Aristolochia acuminata* were planted in various obscure areas of HortPark and this actually brought about the successful breeding and observations of the Common Birdwing and Common Rose and their caterpillars in the park.

Subsequently, extensive plantings of more host and nectar plants (such as the *Antigonon leptopus*, *Citrus* species) of various butterfly species were added to the Irrigation Pond and other parts of the park to continue the breeding programme. A conscious effort was also made

to not eradicate the presence of some common garden weeds (e.g., *Cleome ruidosperma*, *Ruellia repens*), parasitic plants on trees (e.g., *Dendrophthoe pentandra*), and some existing less desirable trees (e.g., *Adenanthera pavonina*, *Cinnamomum iners*) in the vicinity, known to be butterfly host plants. They were allowed to grow in certain localised areas and controlled in its spread in others. With these efforts, occasional to frequent sightings of the Lime Butterfly, Painted Jezebel, Peacock Pansy, Plain Nawab, and Common Bluebottle, in the park were possible.

Naturally, the drastic reduction in the use of harmful inorganic pesticides and chemical substances and targeted pesticide application on specific plants also contributed to a butterfly friendly environment that saw the successful proliferation of a wide diversity of butterflies in the park.

HortPark has been rather successful in its creation of a butterfly friendly environment and its documentation of the breeding attempts of the butterflies. As such, it has started sharing this knowledge and experience in other public platforms such as library and community talks.

In November 2010, HortPark together with Singapore's ButterflyCircle and Oh Chin Huat Hydroponics Farms (Pte) Ltd worked with over 90 schools to plant up the host plant of the Common Birdwing, the *Aristolochia acuminata*, in the schools' premises. Their objective was to provide a valuable food source for this vulnerable butterfly species to enable its continued survival. The desired outcome of this outreach project is to enable students to have a greater awareness and understanding of butterflies as well as promote the conservation of butterfly habitats in Singapore.

Other Projects

A separate project led by the Nature Society of Singapore (NSS) and supported by National Parks Board, Singapore Tourism Board, and Orchard Road Business Association, was initiated in early 2010 to create a four-kilometre urban butterfly trail of sustainable habitats



LEFT TO RIGHT A common garden weed *Cleome ruidosperma*; the Butterfly Garden enclosure at HortPark.



right in the heart of our bustling Orchard Road shopping belt. Stretching from Singapore Botanic Gardens to Fort Canning Park, the trail serves as a bridge for the butterflies to breed and move around the various pockets of green spaces there, such as the Penang Road Open Space, Istana Park, and Stamford Green. In their effort to encourage more community involvement in this meaningful project, NSS has also started discussions with building owners who have properties along the trail to incorporate butterfly-attracting plants within their rooftop gardens. Orchard Central is one example of an enthusiastic partner.

One year on, the project is starting to show signs of success. In a survey conducted in April 2011, there were about 40 species of butterflies recorded along this trail, of which at least 10 are considered uncommon, including the Tawny Coster and Black Veined Tiger. Apart from enhancing the urban population of butterflies, the trail also creates a wonderful opportunity for the public to enjoy sights of these flying beauties.

Numerous other park owners recognised the immense value of having these living creatures in a park's physical environment and similarly worked with the pioneer team from HortPark to set up butterfly themed trails and friendly habitats with the intention to help raise the butterfly species' biodiversity and population within their parks. By capitalising on the presence of dense forest vegetation in and around the vicinity of the parks, coupled with the additional planting of a range of host and nectar plants at strategic locations within the park and along walking trails, Mount Faber, Stamford Green, and Ang Mo Kio Town Garden West too achieved great success in showcasing the vast and interesting diversity of butterflies to the visitors of the park.

Conclusion

If we observe carefully, butterflies are always in our midst and are an essential part of our ecosystem because of their importance as environmental and plant biodiversity indicators and indispensable flowering plant pollinators. In addition, these natural beauties add vibrancy to our built-up environment through the extrinsic and intrinsic values they provide us with their short fleeting lives.

At least a third of native butterflies are locally extinct and most extant species are continuously facing threats of extinction due to habitat loss and destruction. Conscious and concerted efforts to create butterfly friendly habitats amidst our national development provide a conducive living environment not just for butterflies but other equally important, if not attractive, animals that contribute to our island's high faunal biodiversity and serve to slow down, if not halt, their extinction.

Studies on butterflies and their in-situ and ex-situ breeding and conservation are still ongoing at HortPark and it would take some time before a detailed understanding of all known butterfly species can be documented comprehensively. Through the efforts of continual education, outreach projects, and the enthusiasm of butterfly activist groups such as ButterflyCircle and NSS, more can be done as part of the butterfly species recovery programme to promote its conservation and for butterflies to thrive in our physical living environment.

In the meantime, let us all do our parts and what we can to give our future generation a great, vibrant, physical living environment with a healthy ecosystem to live, work, and play in. 



ABOVE, CLOCKWISE FROM TOP LEFT A beautifully planted up butterfly park at the Stamford Road and Bras Basah Road junction, which is part of the four-kilometre butterfly trail; a Common Rose (*Pachliopta aristolochiae*) butterfly; a Common Grass Yellow (*Eurema hecabe*) butterfly on *Leea rubra*; a painted Jazebel (*Delias hyparete*) butterfly on a bougainvillea flower; the Butterfly Garden enclosure at HortPark.

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List of Butterflies and their Related Plants



- nectar plant
- bird attracting
- fragrant flowers
- parasitic plant
- cycad
- groundcover
- climber
- shrub
- tree

PLANT SPECIES	COMMON NAME	HABIT/CHARACTERISTIC	HOST BUTTERFLY
<i>Adenanthera pavonina</i>	Saga Tree, Red Bead Tree	tree	Plain Nawab, Blue Nawab
<i>Aloysia virgata</i>	White Butterfly Bush, Incense Bush, Sweet Almond Bush	tree, nectar plant, bird attracting	
<i>Alstonia scholaris</i>	Indian Pulai, Devil Tree, Blackboard Tree	tree, nectar plant, bird attracting	
<i>Annona muricata</i>	Soursop	tree, nectar plant, bird attracting	Tailed Green Jay
<i>Antigonon leptopus</i>	Coral Vine, Honolulu Creeper	climber, nectar plant, bird attracting	
<i>Ardisia elliptica</i> *	Sea-shore Ardisia	tree, nectar plant, bird attracting	Harlequin, Malayan Plum Judy
<i>Aristolochia acuminata / tagala</i>	Dutchman's Pipe Vine, Indian Birthwort	tree, nectar plant, bird attracting	Common Birdwing, Common Rose, Black Rose
<i>Asclepias curassavica</i>	Blood Flower, Milkweed	tree, nectar plant, bird attracting	Plain Tiger
<i>Asystasia gangetica</i>	Common Asystasia	tree, nectar plant, bird attracting	Great Eggfly, Blue Pansy, Autumn Leaf, Jacintha Eggfly
<i>Bidens alba</i>	Spanish Needles, Beggar's Tick	tree, nectar plant, bird attracting	
<i>Breynia disticha</i> 'Roseo-picta'	Snowbush	tree, nectar plant, bird attracting	Common Grass Yellow
<i>Buddleia davidii</i>	Summer Lilac, Butterfly Bush	tree, nectar plant, bird attracting	
<i>Caesalpinia pulcherrima</i>	Peacock Flower	tree, nectar plant, bird attracting	Common Grass Yellow
<i>Calliandra emarginata</i>	Powderpuff Tree	tree, nectar plant, bird attracting	Common Grass Yellow
<i>Calliandra haematocephala</i>	-	tree, nectar plant, bird attracting	Common Grass Yellow
<i>Calotropis gigantea</i>	Crown Flower, Giant Milkweed, Ivory Plant	tree, nectar plant, bird attracting	Plain Tiger
<i>Cassia fistula</i>	Golden Shower Tree	tree, nectar plant, bird attracting	Lemon Emigrant, Mottled Emigrant, Orange Emigrant
<i>Cassia mimosoides</i>	-	tree, nectar plant, bird attracting	No Brand Grass Yellow
<i>Cerbera odollam</i> *	Pong Pong	tree, nectar plant, bird attracting	King Crow
<i>Cinnamomum iners</i> *	Wild Cinnamon	tree, nectar plant, bird attracting	Common Bluebottle, Common Mime
<i>Citrus</i> sp.	Lime, Lemon	tree, nectar plant, bird attracting	Lime Butterfly
<i>Cleome rutidosperma</i>	Fringed Spiderflower, Wild Cat's Whisker	tree, nectar plant, bird attracting	Cabbage White, Psyche, Striped Albatross
<i>Clerodendron paniculatum</i>	Pagoda Flower	tree, nectar plant, bird attracting	
<i>Cordia cylindristachya</i>	String Bush	tree, nectar plant, bird attracting	Striped Albatross

