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Study on Butterfly Visitation Patterns of *Stachytarpheta jamaicensis* as a Beneficial Plant for Butterfly Conservation

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***Abstract*—**The butterflies are ecologically very important insects. The adults generally feed on nectar and are important as pollinators of flowering plants. However, these pollinators are under threat with their habitat loss. One reason for habitat loss is spread of invasive plants. However, there are even beneficial exotic plants which can directly support for Butterfly Conservation Action Plan of Sri Lanka by attracting butterflies for nectar. *Stachytarpheta jamaicensis* (L.) is an important nectar plant which attracts a diverse set of butterflies in higher number. It comprises a violet color inflorescence which last for about 37 hours where it attracted a peak of butterflies around 9.00am having around average of 15 butterflies. There were no butterflies in early and late hours where the number goes to very low values as 2 at 1.00pm. it was found that a diverse group of butterflies were attracted from around 15 species including 01 endemic species, 02 endemic subspecies and 02 vulnerable species. Therefore, this is a beneficial exotic plant that could be used in butterfly attraction and conservation however with adequate monitoring of the plant population.

***Keywords*—**Butterflies, exotic plants, pollinators, *Stachytarpheta jamaicensis* (L.), butterfly conservation

I. Introduction

BUTTERFLIES are important in several aspects in addition to the service as pollinators; provide aesthetic value, act as a prey in food chains and in food webs. There by butterflies contribute in balancing the eco system while maintaining the biodiversity. And also butterflies act as a source of income through the emerging concept called ecotourism. Since it gives higher value in eco-tourism, butterfly gardens are constructed in different countries to attract lot of nature lovers which will ultimately generate foreign exchange for a country. Further butterflies can be used as indicators in a healthy eco system [1]. Thus, they play a valuable role in maintaining biodiversity. Butterflies (order Lepidoptera) are currently classified under the Superfamily *Papilionoidea*, which includes the skippers (family *Hesperiidae*) and the moth-butterflies (family *Hedylidae*) [7]. Accordingly, the butterfly fauna of Sri Lanka comprises 6 families: *Papilionidae*, *Pieridae, Riodinidae, Lycaenidae, Hesperiidae* and *Nymphalidae* where a total of 245 butterfly species has been recorded with 26 endemic and 86 endemic subspecies [6].

Even though this important insect and most of the species are endangered or under threat it mainly because of human being [3] [5]. It is little suspicious whether; butterflies are safe further with continuous habitat destruction with rapid urbanization. This will destroy both larval feeding plants and adult nectaring plants which ultimately result no breeding places for butterflies. Different countries have different flora and fauna conservation plans for particular country or region. However most of the guidelines are in black and white rather practicing because of unawareness. According to Butterfly Conservation Action Plan of Sri Lanka – 2014 [2] issued by Biodiversity Secretariat, size of the butterfly population has been reduced in relation to the disappearance of food plants and habitats in all climatic zones of Sri Lanka where it stresses the conservation actions for butterflies in Sri Lanka.

Urbanization leading to deforestration and spread of Invasive species in the local eco system is responsible mostly for butterfly habitat destruction. With rapid deforestation, both larval feeding plants and habit plants are being destroyed. Further, with profit based agriculture, agro chemicals are applied heavily for the environment. By applying insecticides, almost all stages of the butterfly life cycle can be destroyed. Application of weedicides may cause severe loss of nectaring and larval feeding plants in great extent. Therefore, there are obvious reasons for the declining butterfly population and biodiversity.

It is evident that the majority of larval food plants and butterfly nectar plants are weeds where some are native plants, some are exotic plants and some are invasive plants. Invasive plants competitively displace the native flora while making a severe threat for their dependents causing a great loss in flowering plants and thereby reducing the food sources both larval feeding plants and adult nectaring plants. However, it is evident that some exotic and invasive plant species such as *Lantana camara* are being used for butterfly gardens due to attractive colorful flowers with nectar.

Stachytarpheta jamaicensis is also a famous butterfly attracting exotic plant to Sri Lanka. (commonly called as blue snake weed, Balunakuta (Sinhala)) belongs to family *Verbanaceae*. However, it has not been identified so far as an invasive species in Sri Lanka and the plants are naturally growing in dry/intermediate regions. Therefore, this study was conducted to study the ability of *S. jamaicensis* plant and inflorescence in attracting butterflies, the butterfly visitation patterns, and flowering phenology in order to use *S. jamaicensis* plant as a beneficial butterfly attracting plant. And also this study was carried out to identify the possibility of this plant as an important food source in national butterfly

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conservation process and to be used with butterfly gardens to support with tourism industry.

II. Materials and Methods

A. Site Description

Natural vegetation of *Stachytarpheta jamaicensis* was identified from Kuliyapitiya area (IL1a) in Kurunegala District to study the flowering phenology and butterfly visitation patterns. The study was carried out from August to October, 2015in a period where there are more butterfly visits during the year. More than 25 flowering *S. jamaicensis* plants in natural vegetations were used in the study without considering the age of the plants. Study was conducted in 03 locations with patches of natural blue snake weed plant populations in the same area.

TABLE I
Weather Data for Duration

Month	Day temperature °C		Average rainfall mm
	Maximum	Minimum	
August	31.0	26.0	10
September	30.0	25.0	22
October	30.0	24.0	38

The study was comprised of three basic studies, plant morphological study, study of flowering phenology and more importantly, the butterfly visitation including the number and the species of butterflies visited the *S. jamaicensis* inflorescence.

B. Plant Morphology

Above ground plant vegetative characteristics such as; leaf arrangement, margin, apex, leaf shapes etc. and reproductive characteristics such as; inflorescence type, flower type, color, length of inflorescence and fruit type were observed to specifically identify the species from other species available in the area.

C. Flowering Phenology

The particular time period of the day for flowering and duration for unfolding, full bloom, senescence and falling were studied. Number of flowers per inflorescence were counted randomly in the same plant population consisted of about 25 flowering plants. Observations were made throughout the day to observe the particular time precisely.

D. Butterfly Visitation

Butterfly visitations for *Stachytarpheta jamaicensis* plants were observed from 6.00am to 5.30pm in hourly intervals. Each observation was continued for a period of 30 minutes per each hour to study almost all species which are visiting the plant for nectar. Butterflies were observed for about 10 days with 6 day interval. Total number of butterflies visited the inflorescence was recorded with the respective time of visit. And also the different species with their number were recorded and almost all visited species were photographed (Some were not photographed due to quick moving). Sunny days were selected to observe the number of butterflies and the species diversity as cloudy days alter the natural behavior of butterflies.

E. Data Analysis

Data were analyzed using MS Excel 2007 wherever necessary.

III. Results and Discussions

A. Plant Morphology

The plants comprised of opposite leaves with denticulate leaf margins. *Stachytarpheta jamaicensis* is an annual herbaceous plant and sometimes perennial that grows 60-120cm tall [4]. Upper leaf surface was shinny and however with rough feel. Leaf shape is elliptic where leaves contain acute apex (Fig. 1).

Inflorescence was a spike with sessile flowers and flowers were in attractive purplish color with average of about 05 fused petals. One spike was with about 18cm on average in length where it elongates over the time.

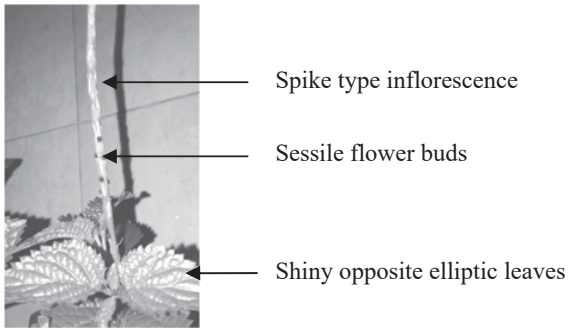

Fig. 1 *S. jamaicensis* leaves and inflorescence

B. Flowering Phenology

The plant produced spikes with purplish sessile flowers. Small flower buds started unfolding around 1.50am and full blooming was taken place around 3.35 am in the following day (Table II).

Accordingly, individual flowers were lasted for about 37 hours. Though it has a lengthy exposing time for butterflies more than a day, the benefit is much limited since butterflies are not active in darker time especially before 6.00a.m. and after 4.00p.m. (Fig. 1). Accordingly, only about 10 hour period is actively used by butterflies for nectaring as shown in Fig. 1. The average of about 20 flowers was produced per spike where about 05 days were taken to complete flowering on a spike as flowers were not bloomed simultaneously. On average there were only 4 – 5 flowers bloomed daily where it was sufficient enough to attract higher number of butterflies with a greater diversity of species and families.

A lengthier period of the flower is not accessible by butterflies as unfolding, full bloom happens at darker periods. It took almost a day (24 hours) to unfold the flower completely. Flower senescence started around 2.00pm and happened within 01 hour and falling started at around 3.00 pm.

TABLE II
FLOWERING TIME AND DURATIONS

Flowering stage	Time	Duration
Unfolding	1.50am ± 0.08	
Fully bloom	3.35am ± 0.18	24.45±0.43
Senescence	2.03pm ± 0.35	36.13±0.40
Falling	3pm ± 0.37	37.1±0.57

C. Butterfly Visitation

1.Number of Butterfly Visitations

According to the observations, the highest mean number of butterflies were visited between 8.00 to 9.30am where there were no butterflies visited from 6.00 - 6.30am and 4.00 – 5. 30pm (Fig. 2).

After the first peak, the number has been drastically declined as sun comes to overhead position. It is of minimum at 1.00pm and produces another peak at 2.00pm with 04 butterflies. The number of visits have been reduced again after the 2nd peak. One reason may be the senescence of flowers at about 2.03pm (Table II). As flowers started falling after 4.00pm, no butterfly visits could be seen after 04.00pm. However, butterflies could do nectaring for about 07 hours period while the flowers were with its full bloom. Though the flower lasted for about 37 hours from unfolding to falling (Table II), only limited period is available for butterflies as blooming happened at dawn in everyday. However, this period is very effective in attracting diverse set of species of Lepidopteron.

Butterflies are cold blooded insects which they do not generate enough heat from their own metabolism to provide them with the heat and energy they need to fly. Therefore, butterflies rely on heat absorbed from the sun.

They will often bask in the sun in the morning or on a cloudy day to help get their temperature up. If the temperature gets too hot, they will reposition their wings to minimize exposure to the sun. These may be the reasons for reduction of the number at hot hours in the day. This need to absorb heat from their environment is the reason why so many butterflies have darkly colored bodies [3].

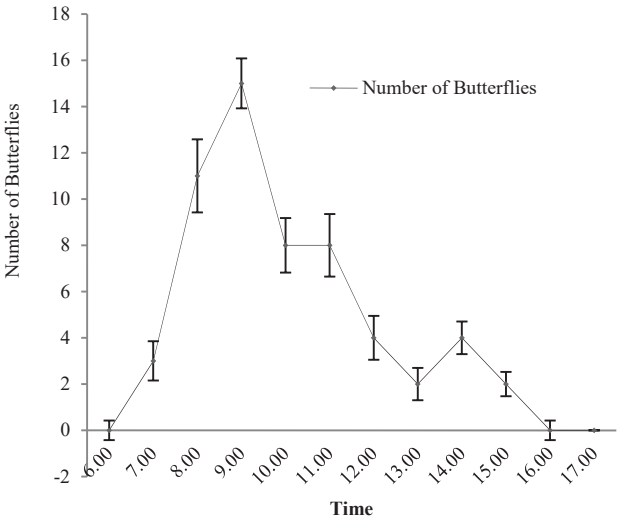

Fig. 2 Mean number of butterfly visitations at different time of the day

TABLE III
BUTTERFLY SPECIES VISITED FLOWERS OF *S. JAMAICENSIS* [3], [5]

Family	Species name	Common Name	IUCN category	Status	Common Sinhala Name
Nymphalidae	*Junonia atlites*	grey pansy	LC	Not endemic	AluPansaya
	Junonia iphita	Chocolate Pansy / Chocolate Soldier	LC	Not Endemic	Miyuru-Hewa
	Acraea terpsicore	The Tawny Coster	LC	Not Endemic	Viyola
	Ypthima ceylonica	The White Four ring	LC	Not Endemic	SithiriSiwwa
	Euploea core	Common Indian crow	LC	Endemic subspecies	InduKakaya
	Ideopsis similis	Blue glassy tiger	VU	Not Endemic	MahaNilkotithiya
	Delias eucharis	The Common Jezebel	LC	Not endemic	PililaRisiya
Pieridae	*Appias lyncida*	Chocolate Albatross	LC	Endemic sub species	Dumburuwan Sudana
	Appias galene	Sri Lanka Lesser Albatross	LC	Endemic	Sri Lanka Thundu Dingupath Samanalaya
	Pieris rapae	The small white			
	Eurema hecabe	Common Grass Yellow	LC	Not Endemic	Thruna Pithaya
Hesperiidae	*Pelopidas conjuncta*	The Conjoined Swift	VU	Not endemic	Wihanga sariya
	Oriens goloides	Common Dartlet	NT	Not endemic	Sariththa
Papilionidae	*Papilio demoleus*	The common lime butterfly	LC	Not Endemic	Dehirisia
Lycaenidae	*Lycaena phlaeas*	The small copper			

Butterflies can fly as long as the air is between 60°-108° F, although temperatures between 82°-100° F are the best [6]. If the temperature drops too low, they may seek a light colored rock, sand or a leaf in a sunny spot and bask.

Usually as shown in Table I, the study duration was having optimum temperatures for butterflies with of average of about 31ºC which may support the normal behavior of butterflies during the day time.

2.Species Diversity of Butterflies

Total of about 14 number of butterfly species and subspecies were observed per day during the study where there was no incidence where the same species visited the *S. jamaicensis* flowers throughout the day though the same species appeared time to time within a day.

It was showed that they preferred specific time of the day for their feeding. Different species prefer different time of the day.

The highest number was recorded from Sri Lanka Lesser Albatross (*Appiasgalene*) which is an endemic species to Sri Lanka. Interestingly Sri Lankan Ministry of Environment has declared this species as the provincial butterfly for North Western Province where the study sites were located.

It was found that the visitation of the vulnerable species The Conjoined Swift (*Pelopidas conjuncta*) at early hours of the day which was found to be rear in certain literature.

Junonia atlites (Grey pancy) was found in couples even in noon hours which were actively nectaring from the *S. jamaicensis* inflorescence.

Accordingly, there was one species (*Ideopsis similis*) belongs to 'vulnerable' (VU) Red list category which are considered to be facing a high risk of extinction in the wild. Another one species identified (*Oriens goloides*) was belonged to the category 'Near threatened' (NT) which is likely to qualify for a threatened category in the near future. Therefore, *S. jamaicensis* plants play a vital role in conserving the threatened and near threatened butterfly species by providing habitat and nectar.

The majority of the observed butterfly species were in the 'Least Concerned' (LC) category where they have been identified as widespread and abundant species.

The plant is beneficial in using for butterfly conservation because it showed that some endemic species *Euploea core*, *Appias galene* and *Appias lyncida* were attracted by *S. jamaicensis* inflorescence (Table III).

The highest number of species (06) visited was recorded from Family Nymphalidae which is the largest family of butterflies.

Specially, the higher species diversity observed in the study may be possible due to the season of the year. In general, in the butterflies tend to migrate from the countries which are having winter and relatively cool temperatures to the countries which are warmer at that particular season in order to generate energy for flying as they are cold blooded insects. As many of the observed species are not endemic, it can be suspected that there have been migrations during this period.

In addition to the butterflies and moths, a number of honey bees, wasps, other insects were observed where most of the insects could not be identified easily.

IV. Conclusion

The *Stachytarpheta jamaicensis* is a flowering plant with a very attractive spike type inflorescence where individual flower lasts for about 37 hours. However only about 07 hours of full bloom is accessible by butterflies as the most stages of the flowering takes place at dark.

There was a high demand for exotic flowering plant *S. jamaicensis* from diverse set of butterfly species. It attracted higher number of butterflies from different species and sub species where even some species were under threat of extinction. It attracted about 15 species a day from 7.00 am to 3.00 pm with a peak at around 9.00 am. Accordingly, this plant has the capacity of attracting and feeding diverse set of butterflies from endemic, vulnerable, threatened and least concerned categories. This plant was able to attract 01 endemic species, 02 endemic sub species and 01 vulnerable species on average per day during the study period. Therefore, the plant can be positively introduced in butterfly attraction for butterfly gardens and thereby the threatened species can be conserved in situ. Habitat conservation can be easily practiced with this perennial plant. Hence, this plant may act as a good nectar source in butterfly gardening where it moreover contributes in bringing pollinators. Since species diversity attracted towards the inflorescence is higher, it can be considered as an important plant to be introduced in eco-tourism. However, this introduction may lead problems in future if the plant populations are not monitored properly since it is an exotic plant to Sri Lanka. Therefore, the benefits have been taken with care to not to become this an invasive plant in future.

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