SEASONALITY, ABUNDANCE AND REPRODUCTION OF SOME LYCAENIDAE BUTTERFLY SPECIES OF EASTERN GHATS OF SOUTHERN ANDHRA PRADESH

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ABSTRACT *Seasonal and reproductive studies along with monitoring of the adults in flight in the habitats of Sri Lankamalleswara Reserve forest, Kadapa and its surrounding were successfully studies. The flight and reproductive periods of 13 Lycaenidae butterfly species are presented. The climate is of tropical monsoon type with winter (December – February), summer (March - May) and rainy (Southwest monsoon June – September, Northeast monsoon October - November) seasons. Five species Chiladespandava, Chiladeslajus, Talicadanyseus, Euchrysopscnejus andCastaliusrosimon had their adult flight throughout the year, and the others Tarucusnara, Zizeeriakarsandra, Rathindaamor, Curetisthetis, Lampidesboeticus, Jamidesceleno, Prosotasdubiosa and Rapalamanea during specific periods of the year: December, Jan – November, August, January and August, January, August to December, August – December, August - December respectively. Seasonal peaks of abundance were evident with all the species expecting Rathindaamor, Lampidesboeticus, Talicadanyseuswhose population was small. Only Chiladespandava and Euchrysopscnejus reproduced throughout the flight period as evidenced by the occurrence and distribution of early stages. Others had some reproductively inactive flight period, which varied in the length from 1-6 months depending on the species. The period of higher reproduction corresponded well with the peaks of abundance of adults. Such peaks occurred during SW monsoon for Castaliusrosimon, Jamidesceleno and Prosotasdubiosa mid SW (August - September) – NE monsoon for Rathindaamor, Curetisthetis, Lampidesboeticus andJamidesceleno winter, summer for Chiladeslajus. Thus there was no uniform picture of seasonality for all the 13 butterfly species of the study. The different patterns in seasonality and the reproductively inactive period could not be explained on the bias of temperature and rainfall variations. Probably each butterfly species has evolved its own life style; hence seasonal pattern in response to a certain combination of the prevailing environmental factors i.e. temperature, humidity, rainfall in the study zone.*

Keywords: *Lycaenidae, Seasonality, Reproductive, Flight, abundance.*

Summary:
The flight and reproductive periods of 13 Lycaenidae butterfly species are presented. The climate is of tropical monsoon type with winter (December – February), summer (March - May) and rainy (Southwest monsoon June – September, Northeast monsoon October - November) seasons. Five species *Chiladespandava, Chiladeslajus, Talicadanyseus, Euchrysopscnejus* and*Castaliusrosimon* had their adult flight throughout the year, and the others *Tarucusnara*, *Zizeeriakarsandra*, *Rathindaamor*, *Curetisthetis*, *Lampidesboeticus*, *Jamidesceleno*, *Prosotasdubiosa* and *Rapalamanea*during specific periods of the year. Finally there was no uniform picture of seasonality for all the 13 butterfly species of the study. The different patterns in seasonality and the reproductively inactive period could not be explained on the bias of temperature and rainfall variations. Probably each butterfly species has evolved its own life style; hence seasonal pattern in response to a certain combination of the prevailing environmental factors i.e. temperature, humidity, rainfall in the study zone.

Introduction:

Plants have played a significant role in the development of phytophagouscreatures, leading to various adaptations to their differed chemical and physical defenses (Strong et al, 1984). Among the configurations proposed to designate these adaptations are co-evolution (Ehrlich & Raven, 1964) and successive evolution (Jermy, 1984). One evolutionary mechanism contains adaptations to diverse host blooming times (Bush, 1969). Seasonal asynchrony may lead to generative isolation & subsequent separation of host races (Wood et al, 1990; Wood andKeese, 1990).

Habitat alteration, increasing human population, Climate alteration and the anthropomorphic alterations that accompany these issues are sources of important stress to original biota (Walther et al. 2002; Hanski et al. 2006; Algar et al. 2009; Gaston 2009; Thomas 2011; Lemes& Loyola 2013). Insects are outstanding indicator species for recordingalterations in bio-diversity and ecosystems, habitat degradation, as well as the

benefits of habitat reinstatement (McGeoch 1998; Thomas 2011; Gerlach et al. 2013); as their size, short time in generation, distribution & immediate association to their environs make them replyrapidly to habitat changes (Peck et al. 1998; Gerlach et al. 2013)

However, improved host plant use may be problematical as the herbivory is often severe, leading to an improved need to accomplishherbivoryfor the health of the plant. While assimilated pest controlling practices for sheltered species can be designed to control the insect without destructive the habitat, the plant or insect population (Pimentel & Hart 2001; Koi 2013), it is often stimulating to positively navigate organization without destructively impacting one or additional aspect of the biotic community(Pimentel & Hart 2001).

Study area:

Fig. 01: Sri Lankamalleswara Reserve forest

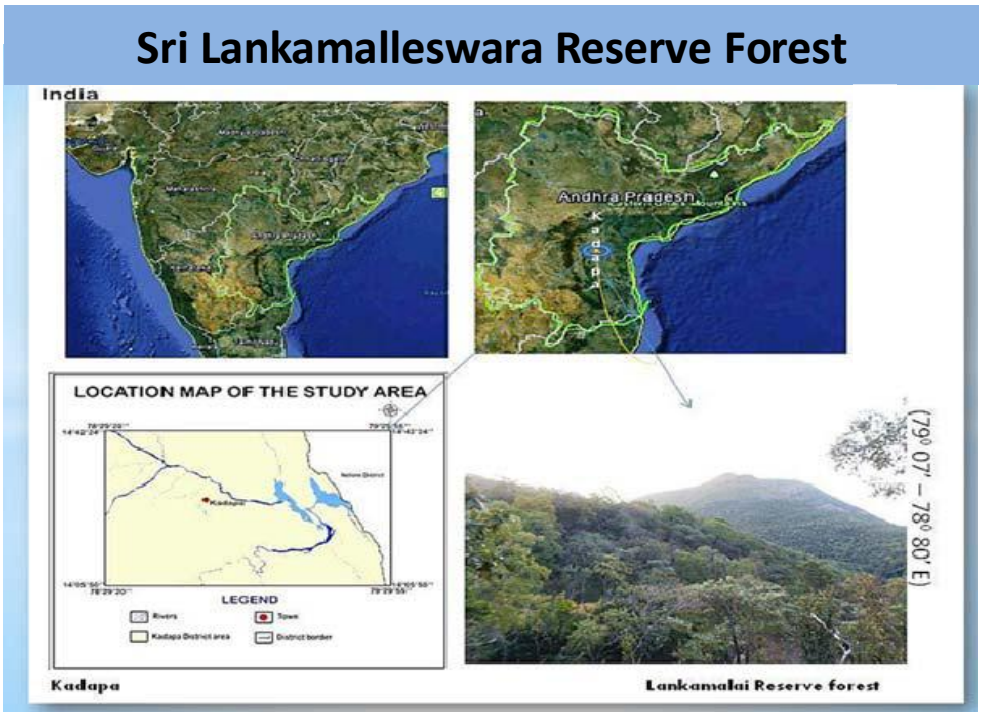

Fig. 02: Study area- Sri Lankamalleswara Reserve Forest,Kadapa

Materials and methods:

The study was made over a period of two years from 2016-2018 in all the study areas of Sri Lankamalleswara forest (Fig. 01 & 02). The study areas maintain wild patches of vegetation with secondary growth. A belt transect approximately 750 mm in length and five meters on either side was marked passing

through the wild patches of vegetation and covering the larval hosts. A walk for two hours along the length of transect was undertaken at 10 – day intervals. The butterflies in the study biotope were found active during 0830 – 1500 hr. Hence walks were made during those hours, mostly between 0900 – 1130 hr. While walking relative abundance of adults were recorded by an arbitrary index as rare, common and very common. Also the early stages on the chosen larval host plants in transect were searched and study of life history in the laboratory facilitated their accurate recognition and enumeration. The food resources of the butterflies along with the flowering period of floral nectar resources were recorded.

Results and Discussion:

Very distinct climatic seasons exist in regions of higher latitudes where butterfly activity was severely limited by severe winter conditions, on the other hand, in the tropics climate was less seasonal, a fairly high temperature prevails throughout the year, and out of the flora generally remain luxuriant throughout or most of the year. Consequently, many species of

butterflies may occur around the year, and each species may reach a peak of abundance during a certain period of the year. This seasonal occurrence of butterflies has been usually measured by fluctuations in the numbers of flying adults and that those fluctuations are taken to follow closely the flight period both in time and intensity. But it was being realized that counts of early staged are the better indicators of population size than adult counts. We describe here the seasonality in 13 species of Lycaenidae butterflies based on simultaneous measurement of both adult and early stages (egg, larvae and pupae put together).

The number of oviposition host plants included in the searches for early stages depended on their size and density as: *Cycuscircinalis* 20 plants for the Plain cupid*Chiladespandava, Citrus limetta*18 plants for the Lime blue*Chiladeslajus*, *Kalanchoepinnata*20 plants for the Red pierrot*Talicadanyseus, Ziziphus jujube* 19 plants for theCommon pierrot*Castaliusrosimon, Ziziphusmauritiana*16 plants for the Rounded pierrot*Tarucusnara*, *Buteamonosperma*11 plants for Gram blue *Euchrysopscnejus*, *Amaranthusspinosus* 13 plants for the Dark grass blue *Zizeeriakarsandra*, *Dendrophthoe falcate* 09 plants for the White Tufted Royal *Pratapa deva, Mangiferaindica*, 10 plants for the Monkey puzzle *Rathindaamor*, *Abruspreceatorius*08 plants for theIndian sunbeam *Curetisthetis*, *Abrusprecatorius* 10 plants for the Pea Blue, *Lampidesboeticus*, *Abrusprecatorius* 09 plants for the Common cerulean *Jamidescelen, Mallotusphilippensis* 12 plants for the Tailless line blue *Prosotasdubiosa*, *Tremaorientalis* 06 plants for the Slate Flash *Rapalamanea.* In case of *Lampidesboeticus*larvae are hidden inside the flowers and the pupae are formed in the soil, hence they could not be enumerated; the eggs only could be spotted on the flower buds and counted.

Of the 13 butterfly species, the adults of only 5 species *Chiladespandava, Chiladeslajus, Talicadanyseus, Euchrysopscnejus* and*Castaliusrosimon* wereencountered in all months of the year with distinct seasonal peaks of abundance respectively occurring during March – December, March – August, August – September and March – December (03,04,05). The other eight species exhibited restricted flight periods: *Tarucusnara*, *Zizeeriakarsandra*, *Rathindaamor*, *Curetisthetis*, *Lampidesboeticus*, *Jamidesceleno*, *Prosotasdubiosa* and *Rapalamanea* during specific periods of the year: December, Jan – November, August, January and August, January, August to December, August – December, August - December respectively. Even these species of limited temporal distribution had discernible peaks of population abundance, expecting *Rathindaamor, Lampidesboeticus, Talicadanyseus*the population of which was of vary low density(Fig. 03,04,05).Of the 13 species, only two *Chiladespandava* and *Euchrysopscnejus* Reproduced throughout their flight period. The other 11 species were reproductively inactive through part of their flight period. This period of sexual diapause was rather long: 6 months (June – December) for *L.nina*, 5 months (January-May), 3months (February – March; July) for the butterflies that undergo sexual diapause as adults live longer than those do not. The differential longevity of such adults becomes an important aspect of seasonality. With the exception of *Rathindaamor, Lampidesboeticus, Talicadanyseus*where there was no noticeable peak, there was complete correspondence of the period of higher reproduction with the peak of abundance of adults.

The distribution and relative frequency of butterflies overtime was usually correlated with the temporal availability of host plants of larvae and adults as well and local rainfall distribution and temperature. There was year round presence of some nectar resources needed by the nectar seeking butterfly species under study (Table 2). The oviposition and larval plants mentioned earlier were also available in all the months of the year for nine species. *Chiladeslajus*, *Zizeeriakarsandra*, *Euchrysopscnejus*, *Rathindaamor*, *Pratapa deva*, *Castaliusrosimon*, *Talicadanyseus*, *Curetisthetis*and *Lampidesboeticus*. In spite of the yearlong availability of food plants, only five species had yearlong flight of other eight specieswas limited to particular periods of the year. The flight and reproductive periods and the peaks of abundance of the butterfly species might be largely governed by the amount and distribution of rainfall, and the temperature variation through the year.

Wynter – Blyth (1956) stated that in South India, the best months for butterflies depend on local rainfall distribution.

The weather data for all the study areas borrowed from the India Meteorological Department (IMD) at Visakhapatnam are given Table 01. IMD recognizes four climatic seasons during a year: Summer March – May, rainy or South-West monsoon June –September, Northeast monsoon October - November, winter December – February. The rainfall was rather heavy during June – November due to the overlapping SW and NE monsoon (Table 01). The rainfall during NE monsoon period was mostly due to cyclones. The temperatures were relatively high during summer and also during SW monsoon period, but in other seasons they were relatively high during summer, and also during SW monsoon period, but in other seasons they were moderate. Cold conditions developed from December and continued till the end of February. The difference between maximum and minimum temperature was below 10^0 C in any month. Analysis of the flight period in relation to these climatic seasons showed that four species (*Lampidesboeticus*, *Euchrysopscnejus, Zizeeriakarsandra, Curetisthetis*) of the eight seasonal species were more frequent during mid-NE monsoons, with some species in peak season spreading to early winter. *Chiladespandava, Chiladeslajus*, occurred during late winter summer months, and *Castaliusrosimon* during late NE monsoon – early summer. The flight periods of 6 of these nine seasonal species correspondent with the SW – NE – winter seasons, and that of *Tarucusnara*, *Euchrysopscnejus*, *Zizeeriakarsandra*, *JamidescelenoProsotasdubiosa*and *Rapalamanea*occurred during winter – summer season. The two *Rathindaamor* and *Tarucusnara* found seasonally in the present study were reported in abundance throughout the year in Sri Lankamalla forest with typical humid tropical rainforest. Probably these species require more moist and shady condition for their occurrence and reproduction. Such conditions were not available in the study biotope throughout the year. Hence their occurrence over a limited part of the year. The peaks of the five annual species could be related to the climatic seasons. *Castaliusrosimon*, *Chiladespandava* and *Chiladeslajus* SW monsoon, *Talicadanyseus*mid SW and early NE monsoon, *Euchrysopscnejus* ,*Zizeeriakarsandra*, *Curetisthetis* and *Lampidesboeticus* winter summer and *Jamidesceleno* Winter months. The breeding activity was high during SW monsoon for *Chiladeslajus*, mid SW – NE monsoon for *Talicadanyseus*and *Chiladeslajus* NE monsoon for *Curetisthetis* and*Zizeeriakarsandra* winter – summer for *Chiladeslajus* and winter for *Rapalamanea* high rate of wet season, Winter – Summer for *Rapalamanea* . *Castaliusrosimon* and *Euchrysopscnejus* this was almost similar to the pattern of flight activity of the butterflies in less seasonal, relatively dry species. Thus the period of monsoons (SW - NE) appear to be most favourable for most butterfly activity. This is almost similar to the pattern of flight activity of the butterflies in less seasonal, relatively dry forest Northern Western Ghats where it was reported to be high during late monsoon (August - September) and early winter (October to November). However, the summer months are not all tighter detrimental to butterfly.

The dry season favoured high rate of reproduction in *Chiladeslajus* such dry season highs in butterflies reproduction is not uncommon: *Talicadanyseus, Rathindaamor* and*Tarucusnara* while agreeing with the statement Wynter-Blyth (1956) that the best months for butterflies in South India depend on local rainfall distribution, the present study found that the spring or Vasanthruthu early part of summer is most favourable period as noted by Wynter – Blyth

(1956) at least for some butterfly species. Under temperate conditions as in Britain, warm, dry seasons are generally beneficial to the abundance of butterflies 13, the 'Seasonal ecotone' effect promoting the abundance of butterflies due to overlapping of dry – and wet season species observed byEmmel&Leck in the tropical rain forest butterfly population in panama is not evident in the distribution of the 13 butterfly species under study.

Some researchers showed that the initiation and continuation of reproduction is under the direct control of rainfall at Assam (North-East India). The Lycaenidae butterfly *Castalisrosimon* was reported to undergo a 100-200 days of reproductively inactive period. Its breeding activity begins with the start of South - West monsoon from April and continues through August, reaches a high frequency during the Northeast monsoon (September - December). Breeding activity ceases at the end of North - East monsoon and the adult emerged at this time survived till the beginning of the following South - West monsoon when they begin to reproduce. Though the lycaenidae higher reproduction of 5 of the13 species coincided with the monsoon period, the kind of response observed for *Talicadanyseus*is not evident with the butterfly species under study. Even another species of *Chiladeslajus* from the present study biotope was shown to be a continuous breeder irrespective of the distribution of monsoon rains.

Table.01: Mean Temperature, Relative humidity, Rainfall and the length for the year October 2016-September 2018.

Month	Temp. (⁰C)						RH (%)		Rainfall (mm)	
	2016-17			2017-18						
	Max	Min	Avg.	Max	Min	Avg.	2016-17	2017-18	2016-17	2017-18
January	33	18	27	31	19	26	65	59	6.1	0
February	36	19	30	34	20	28	49	48	0	0.6
March	39	24	34	38	25	33	45	37	20.1	21
April	43	28	38	41	28	36	34	41	10.2	6.9
May	41	29	36	41	31	37	48	40	59.7	26.6
June	35	27	32	37	29	39	63	46	87.3	66.1
July	37	27	33	35	28	32	48	49	25.4	25.2
August	36	28	33	34	27	31	52	54	176.1	57.1
September	35	27	32	35	26	31	56	56	99.3	126.9
October	35	22	30	30	25	34	57	62	37.6	71.9
November	34	19	28	31	22	27	63	69	21.2	30.2
December	32	18	27	30	19	26	67	68	51.6	1.7

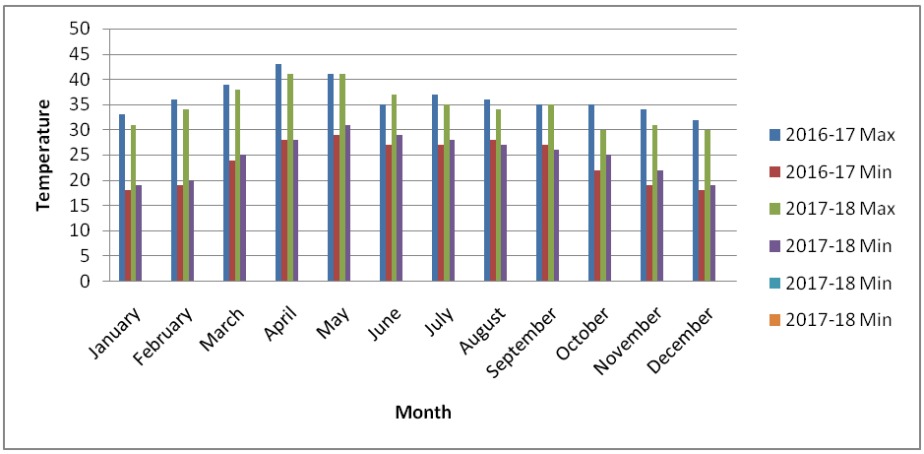

Fig. 03: Mean Temperature at Sri Lankamalleswara Forest during Oct. 2016 to Sep. 2018

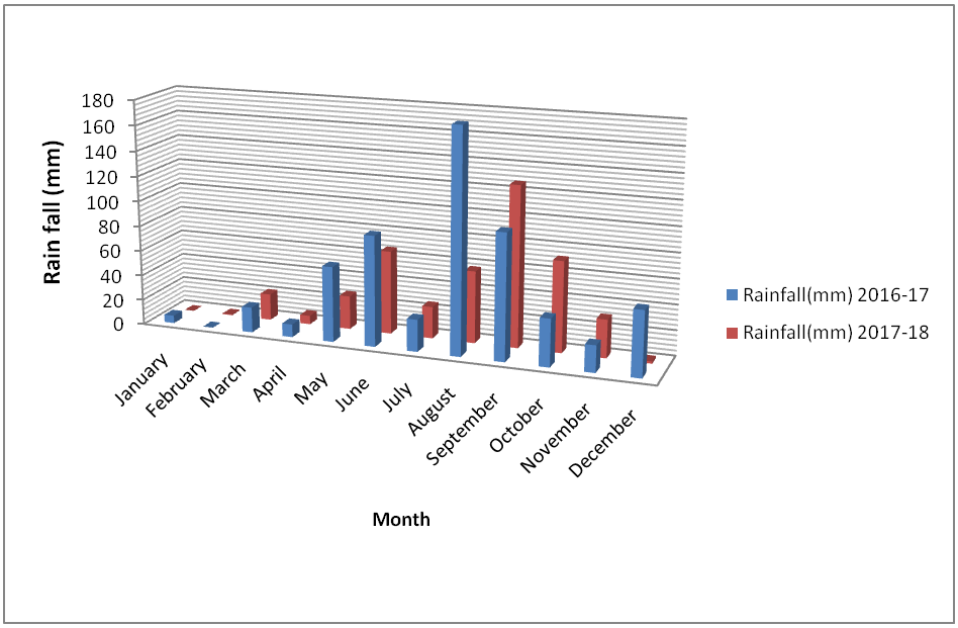

Fig. 04: Mean Rainfall at Sri LankamalleswaraForest during Oct. 2016 to Sep. 2018

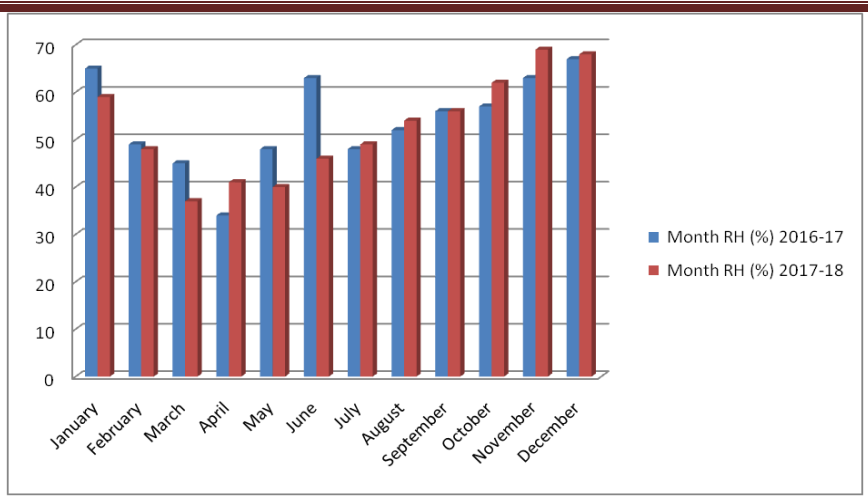

Fig. 05: Mean Relative humidity at Sri Lankamalleswara Forest during Oct. 2016 to Sep. 2018.

Table. 02:Lycaenidae butterflies, their larval host plants details

Butterfly species	Common name	Larval host plant
Chiladespandava (Horsfield, 1829)	Plain cupid	*Cycuscircinalis, C. pectinata, C.revoluta, C. rumphii* (Cycadaceae), *Bauhinia vahlii, B. variegata, Canavaliagladiata, Saracaasoca*(Fabaceae), *Holopteleaintegrifolia*(Ulmaceae)
Chiladeslajus (Stoll, 1780)	Lime blue	*Atalantia, Citrus limetta, C. maxima, Murrayapaniculata*(Rutaceae)
Talicadanyseus (Guerin-Meneville, 1843)	Red pierrot	*Kalanchoepinnata, K. laciniata*
Castaliusrosimon (Fabricius, 1775)	Common pierrot	*Ziziphusjujuba, Z.mauritiana, Z. oenoplia*(Rhamnaceae)
Tarucusnara (Kollar,1848)	Rounded pierrot	*Z.mauritiana*(Rhamnaceae)
Euchrysopscnejus (Fabricius, 1798)	Gram blue	*Buteamonosperma, Canavaliagladiata, Lablab purpureus*(Fabaceae), *Enicistemmalittoorale* (Gentianaceae)
Zizeeriakarsandra (Moore, 1865)	Dark grass blue	*Amaranthusspinosus* (Amaranthaceae), *Glinuslotoides* (Malluginaceae), *polygonumplebeium* (Polygoneacea), *Tribulusterrestris* (Zygophyllaceae).
Pratapa deva (Moore, 1857)	White Tufted Royal	*Dendrophthoefalcata, Scorrulaferruginea* (Loranthaceae)
Rathindaamor (Fabricius, 1775)	Monkey puzzle	*Mangiferaindica* (Anacardiacea), *Barringtoniaacutangula*, *Careyaarborea* (Lecythidaceae), *Ixora brachiate. I. coccinea, I. malabaric*(Rubiaceae), *Schleicheraoleosa* (Spindaceae).
Curetisthetis (Drury, 1773)	Indian sunbeam	*Abruspreceatorius, Aganopethyrsiflora, Buteamonosperma, Pongamiapinnata, Xyliaxylocarpa* (Fabaceae)
Lampidesboeticus (Linnaeus, 1767)	Pea Blue	*Abrusprecatorius, Buteamonosperma, Cajanuscajan, Crotalaria pallida, C. retusa, Gliricidiasepium. Lablab purpureus, Pisumsativum, Vignaunguiculata*(Fabaceae)
Jamidesceleno (Cramer, 1775)	Common cerulean	*Abrusprecatorius, Buteamonosperma, Pongamiapinnata, Saracaasoca, Vignaradiata*(Fabaceae), *Theobroma cacao* (Malvaceae), *Elettariacardamomum*

		(Zingiberaceae)
Prosotasdubiosa (Semper, 1879)	Tailless line blue	*Mallotusphilippensis* (Euphorbiaceae), *Leucaenaleucocephala, Pithecellobium*(Fabaceae), *Mimosa pudica*, *Acacia torta* (Mimosaceae)
Rapalamanea(Hewitson, 1863)	Slate Flash	*Tremaorientalis* (Cannabaceae), *Quisqualisindica* (Combretaceae), *Clerodendruminfortunatum*(Lamiaceae), *Duabangagrandiflora* (Lythraceae), *Lantana camara* (Verbenaceae)

Fig. 06: Identified Lycaenidae butterflies at Sri Lankamalleswara Reserve Forest.

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