



Mutualistic Interaction of Lycaenids (Lycaenidae: Lepidoptera) with Ants and their Behavioural Response to the Environment

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Abstract: A maiden survey was conducted to ascertain the lycaenid larva associated with ant species and their coloration change, mud puddling behaviour, wing position, host plants, pollination beneficiary and nectar yielding plant species for lycaenid butterflies. Two aspects of the interactions between the larva of the *Euchrysops cnejus* and the ant, *Componotus compressus* were studied in the laboratory. Lycaenids showed their strong mutualistic behaviour with ants for their survival in the environment by benefitting each other. The larval response in delivering the honey dew droplets is proportional to the degree of ants attended. Colouration change revealed that there were two forms viz., WSF and DSF differentiated with markings and spots. The dry season form (DSF) of butterflies was found with markings which were light and a smaller number of spots present on the underside. Places near to water bodies or damp area was preferred by the lycaenids for mud puddling, only males undertake mud puddling in the damp area because they absorb essential elements such as sodium that have been lost during copulation in the form of sperms. Out of 45 species of lycaenid, butterflies recorded in the study area were found with WF, WS, WUHO and WUA position during rest and foraging on flowers but majority of species were found with wing upright and adpressed position at rest. Totally 64 plant species were observed as host plants of lycaenids in which Fabaceae, Rhamnaceae and Combretaceae were most preferred. Out of 24 plant species, Verbanaceae plants was most benefitted by pollination service of lycaenids and they were well attracted to yellow, white and red colour. Most of the lycaenid butterfly species were depend on *Zizyphus* spp., *Tridox procumbens*, *Celosia argentea*, *Saraca asoca*, *Parthenium hysterophorus* and *Bidens pilosa* for their nectar food in the study area out of 30 plant species recorded. Hence, lycaenids are playing a diversified role in the environment for their survival and involves in maintaining the health of environment by their pollination service.

Keywords: *Euchrysops cnejus*, Colourational change, Host plants, Mud puddling, Pollination beneficiary

Butterflies are colourful and scaled winged insects of the order Lepidoptera of class Insecta. Butterflies are an indicator species which responds rapidly to environmental and land use changes and have been recognized as ecological indicators in diverse ecosystems around the world (Ekroos et al 2013, Stuhldreher and Fartmann 2018). More than 18,000 butterfly species are known, and 90 % of these species are distributed in tropical areas (Bonebrake et al 2019). However, tropical butterfly diversity is threatened by habitat loss and global climate change (Jain et al 2017, Kirubaharan et al 2022). Butterflies perform important ecological functions, such as pollinating many plant species, and are thus highly valuable from a conservation perspective (Santos et al 2020). Devi et al (2021) reported that the presence of *Senna siamea* attracts the *Catopsilia pyranthe* butterfly which is commonly found along the roadsides in semi-urban areas. Arya et al (2020) observed that 85.92% male and 14.08 % female butterflies were feeding at various sites as puddles, moist soil, mammalian dung and algal mats. But the most unique aspect of this group is that caterpillars of several species share a very special relationship with ants and because of this particular feature caterpillars of those species have specialized secretory organs or glands to attract and reward and in return for the protection that they

receive from the ants. The degree of ants attendance to caterpillars varies in different species (Kehimkar 2008). One of the most interesting facts that the early stages of many of these butterflies their association with ants who protect them from their many insect enemies in return for the sweet juice they can produce. The ants obtain the juice by gently stroking the hinder part of the caterpillar's body with their antennae causing small drops of a sweet liquid to exude from the mouth like opening in segment 11. The male lycaenid bask with their wings spread out and the upper surfaces of their wings facing the sun. The females also do so, but spend a lot of their time in finding suitable larval host plants as well. Further, he found that butterflies feed on a variety of resources. Many of them were lycaenid butterflies viz., grass blues, pea blue and ceruleans, visit flowers. The majority of males were found visiting flowers and of settling on damp patches to suck up moisture, but the females do not usually have these habits and fly in the open keeping more to the jungles and busying themselves with searching for the foodstuff on which to lay their eggs. Seasonal variation occurs in a number of species, change of color and markings sometimes being very pronounced. The shape of the wings, however, seldom alters. Keeping the above in view, the following research work was carried out.

MATERIAL AND METHODS

An intensive survey was made during 2017-2018 to record the behavioral response of lycaenid butterflies in the following districts of Tamil Nadu. There were 12 districts selected, three each from east, west, north and southern parts of Tamil Nadu are given below. In each district three localities were randomly selected based on their flora and fauna suitable for butterflies. The survey area covered the localities with plains, barren lands, cropped area, hilly tract and forest covers.

Effect of ant attendance on lycaenid larval behavior and honey dew secretion: To investigate the honeydew secretion and the droplet numbers due to the stimulation of attending ant species the experiment was carried out in the laboratory. Fourth instar larvae of *E. cnejus* were collected and three treatments with different numbers of attending ants were setup. In the first treatment, a single ant was allowed to access the larva. Two ants were allowed to access the larva in second treatment. In all the three treatments, ant attending the larval droplet (honeydew) numbers was observed for every 20 minutes. The larval response to stimulated attacks of the ants was observed every five minutes period and the numbers of droplet released were counted. The interaction was observed through a Carl Zeiss Stemi DV₄ Stereomicroscope and every number of ants that touched the larva was counted to give information about the number of ants directly attending to the larva.

Colourational change of lycaenid butterflies: The lycaenid butterfly species bear a very different appearance at different seasons of the year. The change in climate and altered condition of the foodstuff producing different forms in markings and colour. The colour changes in the lycaenids were also observed from the study area while under take a survey in different seasons of the study period.

Mud puddling and wing position of lycaenids: The mud puddling behavior of lycaenid butterflies on moist substance like wet soil, bird-dropping and damp soil patches in different places of hills and plain areas were observed and photographed while surveying for lycaenids in selected localities of Tamil Nadu. The position of wing held at the time of foraging on flowers or at rest were also observed in the lycaenid butterfly species of the study area.

Host plants of lycaenid butterflies for oviposition: The lycaenid butterflies ovipositing host plants of the selected localities in the survey area were observed and the plant species were photographed. They were identified with the help of botanist from the Department of Botany, Annamalai University.

Pollination beneficiary and nectar yielding plant species of lycaenid butterflies: The lycaenid butterflies pollinating plant species of the study area were recorded in different landscape viz., plains, hill, forest, garden, bushy area etc., along with their beneficiary plant species during the study period. All the species of butterflies sighted on different flowering plants species were collected/observed and identified. The nectar yielding plants for lycaenid butterflies of the study area were also recorded along with their beneficiary lycaenid species. All the species sighted on different nectaring plants were collected/observed and identified.

RESULTS AND DISCUSSION

Effect of ant on lycaenid larval behavior and honey dew secretion: The number of attending ants affected the larval behavior on honey dew secretion and tentacle eversions. When the ant, *C. compressus* attended the lycaenid larva by antennal storking on the 7th abdominal segment, the larva raised the tentacles and produce the honey drops and the ant feeds on. When the number of ants having access increased

Districts	Selected localities surveyed
Cuddalore	Annamalainagar (11.38°N and 79.72°E), Kurinjipadi (11.57°N and 76.6°E), Sivapuri (11.38°N and 79.79°E)
Nagapattinam	Sirkali (11.23°N and 79.73°E), Mayiladuthurai (11.10°N and 79.65°E), Kollidam (10.85°N and 79.74°E)
Thanjavur	Orathanadu (10.64°N and 79.22°E), Puthur (10.92°N and 79.27°E), Papanadu (10.28°N and 79.07°E)
Namakkal	Kolli hills (11.24°N and 78.33°E), Senthamangalam (11.30°N and 78.23°E), Rasipuram (11.46°N and 78.18°E)
Salem	Yercaadu hills (11.78°N and 78.21°E), Attur (11.59°N and 78.60°E), Omalur (11.74°N and 78.04°E)
Coimbatore	Mettupalayam (11.28°N and 76.94°E), Siruvani (11.16°N and 76.79°E), Thondamuthur (10.98°N and 76.84°E)
Vellore	Yelagiri hills (12.86°N and 79.03°E), Veppamattu (12.86°N and 79.03°E), Pelampattu (12.86°N and 79.03°E)
Tiruvannamalai	Javvadhu hills (12.58°N and 78.83°E), Arani (12.67°N and 79.28°E), Chengam (12.31°N and 78.79°E)
Villupuram	Kalvarayan hills (11.80°N and 78.76°E), Thindivanam (12.23°N and 79.64°E), Kallakkurichi (11.73°N and 78.95°E)
Madurai	Melur (10.05°N and 78.33°E), Tirumangalam (9.91°N and 77.98°E), Usilampatti (9.97°N and 77.8°E)
Tirunelveli	Kutralam (9.89°N and 78.03°E), Vasudevanallur (9.24°N and 77.41°E), Kalakkad (8.51°N and 77.55°E)
Kanyakumari	Thovalai (8.22°N and 77.50°E), Suchindram (8.15°N and 77.46°E), Kulasekharapuram (8.14°N and 77.50°E)

from one to two the larva almost doubled the number of droplets secreted which accounts 2.15 and 3.90 . respectively. The number of ants increased even more, there was no further increase in larval droplet. The tentacle eversions were observed for a period of 20 minutes and maximum eversion was observed as 34.0 times followed by 25.9 times when two and one ants released respectively. Number of tentacle eversions did not differ significantly between treatments (Table 1) (Plate 1a-1e). The *E. cnejus* larva gave significantly more droplets after a simulated attack of ant species. The doubled number of droplets delivered during the five-minute period was noticed as 3.11 immediately following the attack. The rate of tentacle eversions differed even more between the treatments, increasing by about a factor of five minutes after the attack 21.4. The ants responded to the increased effort of the larvae by increasing the degree of attendance (Table 2).

Colourational change of lycaenid butterflies: Four species of lycaenid butterflies were found with colourational changes on the underside of the wings especially in males of Angled Pierrot, Common Cerulean, Common Pierrot and Gram Blue (Table 3) (Plate 2). In wet season form (WSF) butterflies were seen with dark and more lines or spots on the underside of the wings. The dry season form (DSF) of butterflies was found with markings which were light and less number of spots present on the underside. This might be due to the change in climate and altered condition of foodstuff producing colour markings on the wings. Kehimkar (2008) reported two different forms having dissimilar markings, colour or shapes. The WSF bears a number of eyespots on the underside besides the streaking and dark on the upperside. While in the DSF, the wings are more angular and eyespots are completely absent or reduced to minute dots and unstreamed underside gives a leafy appearance. Such variations are a result of varying environmental factors that help the species in better camouflaging itself for survival in the environmental conditions. The sexes are similar on the underside, although on the upper side males are brighter blue with narrow black borders whereas females had much broader borders. Further, Kunte (2000) also found that dry season form of *Jamides celeno* Cramer, in which the space

between the discal bands on both the wings are filled with dark brown whereas the tornal orange crowned black spot is highly reduced in size and orange coloration.

Mud-Puddling and wing position behaviour of Lycaenidae butterflies: The mud-puddling behaviour of lycaenid butterflies were noticed from Angled Pierrot, Common Line Blue, Tiny Grass Blue, Gram Blue and Grass Jewel in the localities like Kolli hills, Mettupalayam dam, Siruvani dam and Pechiparai area respectively (Table 4) (Plate 3). Only males undertake mud puddling in the damp area because they absorb essential elements such as sodium that have been lost during copulation in the form of

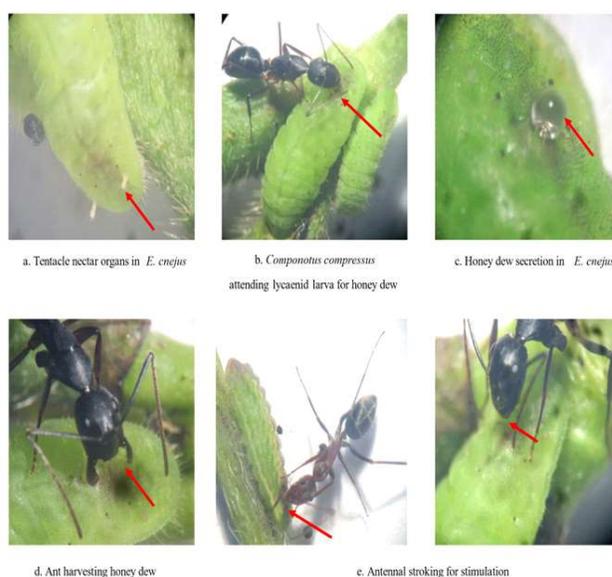


Plate 1. Myrmecological studies on *Euchrypsops cnejus* in association with ant *Comptonotus compressus*

Table 2. Lycaenid, *Euchrypsops cnejus* larval response to stimulated attacks of ant, *Comptonotus compressus*

Interaction between larva and ant	Simulated attack	Control	P
Droplet per 5 minutes	3.11±0.31	2.17±0.39	0.0098
Tentacle eversions per 5 minutes	21.4±0.09	6.9±0.10	0.0009

Table 1. Myrmecological study on the effect of increased ant, *Comptonotus compressus* attendance on lycaenid, *Euchrypsops cnejus* larval behavior and honey dew secretion

Interaction between larva and ant (Time)	Number of ants released			
	1	2	3	P
Droplets/ 20 minutes	2.15±0.31	3.90±0.40	3.08±0.33	0.017
Tentacle eversions/20 minutes	25.9±5.80	34.0±6.90	22.8±5.00	0.950
Attending ants	0.92±0.60	2.75±0.10	3.83±0.27	<0.001

sperms. The excess water that is absorbed is thrown out of the abdomen in the form of droplets. These lycaenids were preferred to puddle on various nutrient sources like wet soil, manures or decomposing materials. Out of 45 species of lycaenid butterflies were recorded in the study area found

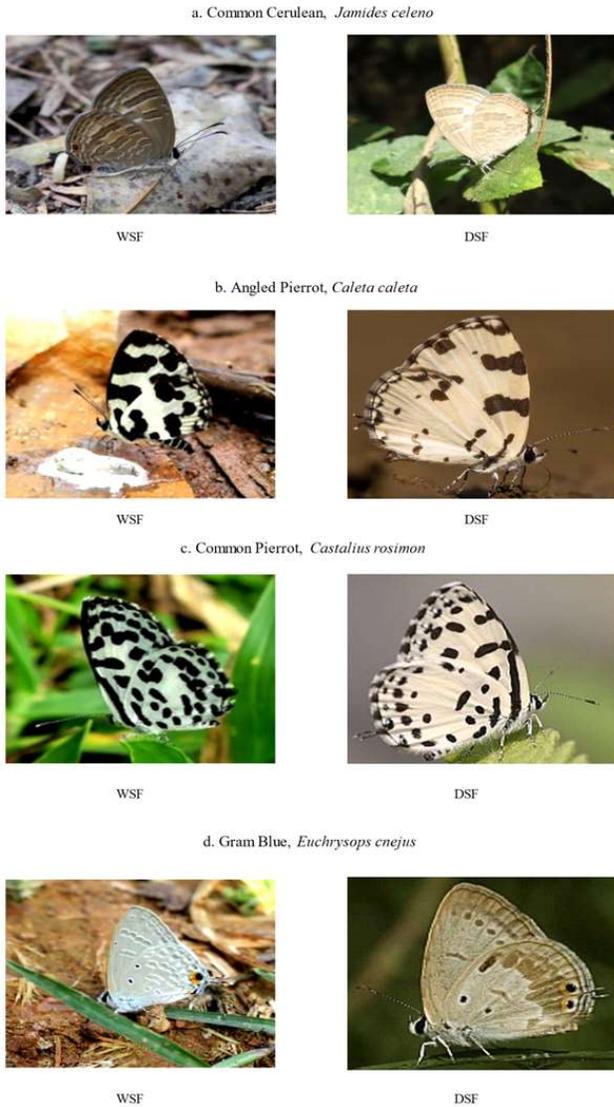


Plate 2. Seasonal diversity (Forms) of lycaenid butterflies in the study area

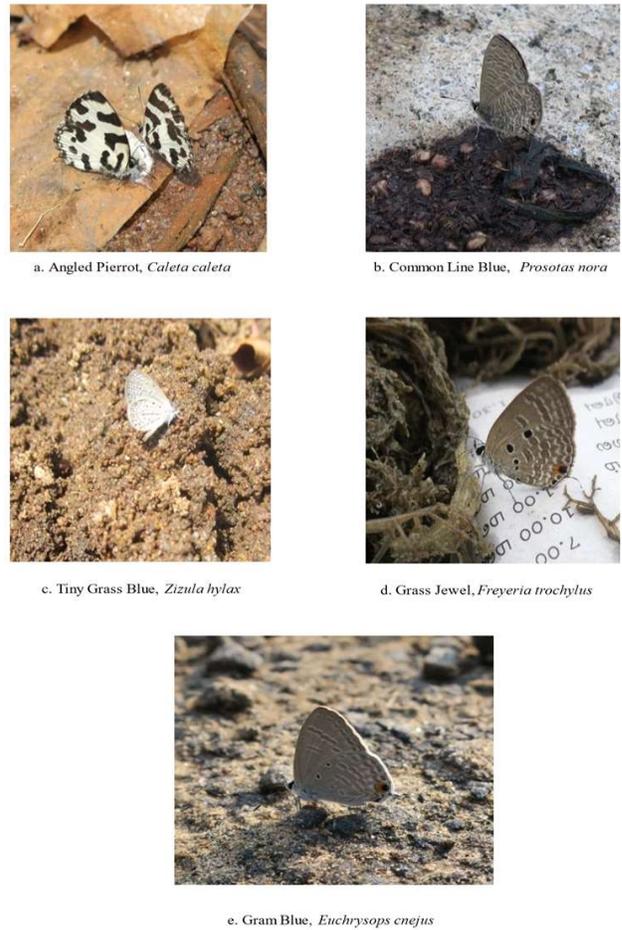


Plate 3. Mud puddling of lycaenid butterflies observed in the study area

Table 4. Mud puddling behaviour of lycaenid butterflies observed in the selected localities study area (2017-2018)

Mud puddling lycaenids	Scientific name	Locality
Angled pierrot	<i>Caleta caleta</i>	Kolli hills
Common line blue	<i>Prosotas nora</i>	Kolli hills
Tiny grass blue	<i>Zizulz hylax</i>	Mettupalayam dam
Gram blue	<i>Euchryspos cnejus</i>	Siruvani dam
Grass jewel	<i>Freyeria trochylus</i>	Pechiparai dam

Table 3. Colourational change of lycaenid butterflies due to seasonal variation in the study area

Common name	Scientific name	Colouration in male	
		Wet season form	Dry season form
Angled Pierrot	<i>Caleta caleta</i>	Wing under side dark parallel lines	Wing under side light parallel lines
Common Cerulean	<i>Jamides celeno</i>	Wing under side bright colour with many scattered spot	Wing under side dull colour with few scattered spot
Common Pierrot	<i>Castalius rosimon</i>	Wing under side bright colour with uneven spot	Wing under side dull colour with even spot
Gram Blue	<i>Euchrysops cnejus</i>	Wing under side bright colour with eye spot	Wing under side dull colour with eye spot and dark hindwing margin

Table 5. Wing position of lycaenid butterfly species observed while foraging at flowers or at rest (2017-2018)

Common name	Scientific name	WF	WS	WUHO	WUA
Apefly	<i>Spalgis epius</i>	+	+	-	+
Common Brownie	<i>Miletus chinensis</i>	-	-	-	+
Indian Sunbeam	<i>Curetis thetis</i>	-	-	+	+
Large Oakblue	<i>Arhopala amantes</i>	-	-	+	+
Indian Oakblue	<i>Arhopala atrax</i>	-	+	-	+
Common Acacia Blue	<i>Surendra quercetorum</i>	-	+	-	+
Leaf Blue	<i>Amblypodia anita</i>	-	+	-	+
Yamfly	<i>Loxura atymnus</i>	-	-	+	+
Common Onyx	<i>Horaga onyx</i>	-	-	+	+
Monkey Puzzle	<i>Rathinda amor</i>	-	+	-	-
Guava Blue	<i>Deudorix isocrates</i>	-	-	+	+
Common Tit	<i>Hypolycaena erylus</i>	-	+	-	+
Cornelian	<i>Deudorix epijarbas</i>	-	-	+	+
Common Tinsel	<i>Catapaecilma elegans</i>	-	-	+	+
Common Silverline	<i>Spindasis vulcanus</i>	-	+	-	+
Common Shot Silverline	<i>Spindasis ictis</i>	-	+	-	+
Common Red Flash	<i>Rapala iarbus</i>	-	+	-	+
Common Ciliate Blue	<i>Anthene emolus</i>	-	+	-	+
Pointed Ciliate Blue	<i>Anthene lycaenina</i>	-	+	-	+
Angled Pierrot	<i>Caleta caleta</i>	+	-	-	+
Common Pierrot	<i>Castalius rosimon</i>	-	+	-	+
Banded Blue Pierrot	<i>Discolampa ethion</i>	+	-	-	+
Zebra Blue	<i>Leptotes plinius</i>	+	+	-	+
Common Line Blue	<i>Prosotas nora</i>	-	+	-	+
Tailless Line Blue	<i>Prosotas dubiosa</i>	-	+	-	+
Dark Cerulean	<i>Jamides bochus</i>	-	+	-	+
Common Cerulean	<i>Jamides celeno</i>	-	+	-	+
Pea Blue	<i>Lampides boeticus</i>	-	-	+	+
Rounded Pierrot	<i>Tarucus nara</i>	-	+	+	+
Dark Pierrot	<i>Tarucus ananda</i>	-	+	+	+
Dark Grass Blue	<i>Zizeeria karsandra</i>	-	+	+	-
Pale Grass Blue	<i>Pseudozizeeria maha</i>	-	+	+	+
Lesser Grass Blue	<i>Zizina otis</i>	-	+	-	+
Tiny Grass Blue	<i>Zizula hylax</i>	-	+	-	+
Indian Cupid	<i>Everes lacturnus</i>	-	+	+	+
Tailed Cupid	<i>Everes argiades</i>	-	+	+	+
Red Pierrot	<i>Talicauda nyseus</i>	-	+	+	+
Quaker	<i>Neopithecops zalmora</i>	-	-	+	+
Gram Blue	<i>Euchrysops cnejus</i>	-	+	+	+
Plains Cupid	<i>Chilades pandava</i>	-	+	+	+
Lime Blue	<i>Chilades lajus</i>	-	+	+	+
Grass Jewel	<i>Freyeria trochylus</i>	-	+	+	+
Plain Hedge Blue	<i>Celastrina lavendularis</i>	-	-	+	+
Pale Hedge Blue	<i>Udara dilecta</i>	+	-	+	+
Transparent 6-Lineblue	<i>Nacaduba kurava</i>	-	-	+	+

WF = Wing fluttering; WS = Wing spreading; WUHO = Wings upright and half opened; WUA = Wing upright and adpressed

Table 6. Larval food (plants/insects) of lycaenid butterflies (2017-2018)

Common name	Scientific name	Food plants/insects
Apefly	<i>Spalgis epius</i>	<i>Paracoccus marginatus</i> (Williams and Granara de Willink), <i>Planococcus citri</i> (Risso), <i>Maconellicoccus hirsutus</i> (Green)
Indian Sunbeam	<i>Curetis thetis</i>	<i>Pongamina pinnata</i> (Linn.), <i>Abrus precatorius</i> (Linn.), <i>Derries scandens</i> (Roxburgh)
Large Oakblue	<i>Arhopala amantes</i>	<i>Terminalia catappa</i> (Linn.), <i>Terminalia alata</i> (Willd), <i>Terminalia paniculata</i> (Roth)
Indian Oakblue	<i>Arhopala atrax</i>	<i>Shorea robusta</i> (Roth)
Common Acacia Blue	<i>Surendra quercetorum</i>	<i>Acacia pinnata</i> (Willd.), <i>Acacia caeisa</i> (Willd.)
Leaf Blue	<i>Amblypodia anita</i>	<i>Olex imbricate</i> (Roxb.), <i>Olex scandens</i> (Roxb.)
Yamfly	<i>Loxura atymnus</i>	<i>Smilax bracteata</i> (C. Presl), <i>Dioscorea pentaphylla</i> (Linn.)
Common Onyx	<i>Horaga onyx</i>	<i>Coriaria nepalensis</i> (Wall.)
Monkey Puzzle	<i>Rathinda amor</i>	<i>Mangifera indica</i> (Linn.), <i>Ixora</i> spp.
Guava Blue	<i>Deudorix isocrates</i>	<i>Tamarindus indica</i> (Linn.), <i>Punica granatum</i> (Linn.), <i>Psidium guajava</i> (Linn.), <i>Gradenia latifolia</i> (Ait.)
Common Tit	<i>Hypolycaena erylus</i>	<i>Cinnamomum zeylanicum</i> (J. Prsel)
Cornelian	<i>Deudorix epjarbas</i>	<i>P. granatum</i> , <i>Aesculus indica</i> (Wall.), <i>Lichi chinensis</i> (Sonn.)
Common Tinsel	<i>Catapaecilma elegans</i>	<i>T. paniculata</i>
Common Silverline	<i>Spindasis vulcanus</i>	<i>Ziziphus mauritiana</i> (Lam.), <i>Ziziphus rugosa</i> (Lam.)
Common Shot Silverline	<i>Spindasis ictis</i>	<i>Dendrophthoe</i> sp. (L.F.), <i>Allophylus cobbe</i> (Linn.)
Common Red Flash	<i>Rapala iarbus</i>	<i>Z. rugosa</i>
Common Ciliate Blue	<i>Anthene emolus</i>	<i>T. paniculata</i> , <i>Saraca asoca</i> (Roxb.)
Angled Pierrot	<i>Caleta caleta</i>	<i>Z. rugosa</i> , <i>Z. mauritiana</i>
Common Pierrot	<i>Castalius rosimon</i>	<i>Z. jujube</i> (Mill.), <i>Z. mauritiana</i> , <i>Z. rugosa</i>
Banded Blue Pierrot	<i>Discolampa ethion</i>	<i>Z. jujube</i> , <i>Z. maritiana</i> .
Zebra Blue	<i>Leptotes plinius</i>	<i>Mimosa</i> spp (Linn.), <i>Sesbania bispinosa</i> (Jacq.)
Common Line Blue	<i>Prosotas nora</i>	<i>Acacia torta</i> (Roxb.), <i>Mimosa</i> spp.
Tailless Line Blue	<i>Prosotas dubiosa</i>	<i>Acacia</i> spp., <i>M. pudica</i> (Linn.), <i>Leucena</i> spp. (Benth.)
Dark Cerulean	<i>Jamides bochus</i>	<i>Xylia dolabriformis</i> (Roxb.), <i>P. pinnata</i> , <i>Crotolaria</i> spp.
Common Cerulean	<i>Jamides celeno</i>	<i>P. pinnata</i> , <i>S. asoca</i>
Pea Blue	<i>Lampides boeticus</i>	<i>Vigna radiata</i> (Linn.), <i>Vigna mungo</i> (Linn.), <i>Cajanus cajan</i> (Linn.), <i>Vigna sinensis</i> (Linn.), <i>Crotalaria</i> spp., (Linn.)
Rounded Pierrot	<i>Tarucus nara</i>	<i>Ziziphus</i> spp.
Dark Pierrot	<i>Tarucus ananda</i>	<i>Jasminum</i> spp. (Linn.) <i>Zizyphus</i> spp.
Dark Grass Blue	<i>Zizeeria karsandra</i>	<i>Tribulus terrestris</i> (Linn.), <i>Amaranthus spinosus</i> (Linn.),
Pale Grass Blue	<i>Pseudozizeeria maha</i>	<i>Oxalis corniculata</i> (Linn.)
Lesser Grass Blue	<i>Zizina otis</i>	<i>M. pudica</i>
Tiny Grass Blue	<i>Zizula hylax</i>	<i>Hygrophila auriculata</i> (Schumach.), <i>O. corniculata</i>
Indian Cupid	<i>Everes lacturnus</i>	<i>Desmodium</i> spp. (Desv.)
Tailed Cupid	<i>Everes argiades</i>	<i>Medicago lupulina</i> (Linn.), <i>Trifolium</i> spp. (Linn.)
Red Pierrot	<i>Talicauda nyseus</i>	<i>Kalanchoe pinnata</i> (Adans.)
Quaker	<i>Neopithecops zalmora</i>	<i>Glycosmis arborea</i> (Retz.)
Gram Blue	<i>Euchrysops cnejus</i>	<i>Vigna cylindrica</i> (Linn.), <i>V. trilobata</i> , <i>V. mungo</i> , <i>C. cajan</i>
Plains Cupid	<i>Chilades pandava</i>	<i>Bauhinia vahlii</i> (Linn.), <i>Holoptelea intergrifolia</i> (Planch.)
Lime Blue	<i>Chilades lajus</i>	<i>Citrus maxima</i> (Linn.), <i>Atalantia racemosa</i> (Wight and Am.), <i>Citrus grandis</i> (Linn.)
Plains Cupid	<i>Chilades pandava</i>	<i>Acacia</i> spp. <i>Cycas revolute</i> (Thunb.)
Grass Jewel	<i>Freyeria trochylus</i>	<i>P. sativum</i> , <i>O. corniculata</i>
Transparent 6-Lineblue	<i>Nacaduba kurava</i>	<i>Waltheria indica</i> (Linn.)

with WF, WS, WUHO and WUA position during rest and foraging on flowers (Table 5). Wing position of different butterflies while foraging on flowers were recorded by Venkata Ramana (2010) in Eastern Ghats area of Andhra Pradesh and observed that majority of lycaenids were noticed with wing upright adpressed (WUA) position.

Larval food (plants/insects) of Lycaenidae butterflies: A total of 42 plant species were observed as lycaenid ovipositing plants or host plants. The lycaenids were more

attracted to various species of plants (Table 6). Most of the plant species were belongs to Fabaceae, Rhamnaceae and Combretaceae family. This might to be due to the larval host plants belong to the above family is available for lycaenids survival and development in the study area. Tiple et al (2009) reported that herbs namely, *Tridax procumbens* and *Tephrosia purpurea* were more used by lycaenid butterflies. Venkata Ramana (2010) reported that the lycaenids like *Talicauda nysus* lays eggs on *Bryophyllum*

Table 7. Important plant species pollinated by lycaenid butterflies (2017-2018)

Common name	Scientific name	Beneficiary Plant/species	Family
Apefly	<i>Spalgis epius</i>	<i>L. camara</i> (Linn.)	Verbenaceae
Indian Sunbeam	<i>Curetis thetis</i>	<i>P. pinnata</i> (Linn.)	Fabaceae
Large Oakblue	<i>Arhopala amantes</i>	<i>Terminalia catappa</i> (Linn.) <i>T. alata</i> (Heyne ex Roth)	Combretaceae
Indian Oakblue	<i>Arhopala atrax</i>	<i>Shorea robusta</i> (Roth)	Dipterocarpaceae
Common Acacia Blue	<i>Surendra quercetorum</i>	<i>Acacia pinnata</i> (Linn.)	Fabaceae
Leaf Blue	<i>Amblypodia anita</i>	<i>Olax imbricate</i> (Roxb.)	Olacaceae
Yamfly	<i>Loxura atymnus</i>	<i>Smilax bracteata</i> (C.Persl)	Smilacaceae
Common Onyx	<i>Horaga onyx</i>	<i>Coriaria nepalensis</i> (Wall.)	Coriariaceae
Common Tinsel	<i>Catapaecilma elegans</i>	<i>Terminalia paniculata</i> (Roth)	Combretaceae
Common Pierrot	<i>Castalius rosimon</i>	<i>Ziziphus</i> spp. (Mill.)	Rhamnaceae
Red Pierrot	<i>Talicauda nyseus</i>	<i>T. procumbens</i> (Linn.)	Asteraceae
Lime Blue	<i>Chilades laius</i>	<i>Citrus</i> spp. (Linn.)	Rutaceae
Pea Blue	<i>Lampides boeticus</i>	<i>T. procumbens</i>	Asteraceae
Pale grass blue	<i>Pseudozizeeria maha</i>	<i>Psidium guajava</i> (Linn.)	Myrtaceae
Common Line Blue	<i>Prosotas nora</i>	<i>Acacia torta</i> (Roxb.), <i>M. pudica</i> (Linn.)	Fabaceae
Tailless Line Blue	<i>Prosotas dubiosa</i>	<i>M. pudica</i>	Fabaceae
Common Red Flash	<i>Rapala iarbus</i>	<i>Nephelium lappaceum</i> (Linn.)	Sapindaceae
Common Ciliate Blue	<i>Anthene emolus</i>	<i>T. paniculata</i>	Combretaceae
Indian Cupid	<i>Everes lacturnus</i>	<i>P. guajava</i>	Myrtaceae
Zebra Blue	<i>Leptotes plinius</i>	<i>L. camara</i>	Verbenaceae
Guava Blue	<i>Deudorix isocrates</i>	<i>P. guajava</i>	Myrtaceae
Tiny Grass Blue	<i>Zizula hylax</i>	<i>L. camara</i>	Verbenaceae
Gram Blue	<i>Euchrysops cnejus</i>	<i>L. camara</i>	Verbenaceae
Dark Cerulean	<i>Jamides bochus</i>	<i>P. pinnata</i>	Fabaceae
Common Cerulean	<i>Jamides celeno</i>	<i>Ziziphus</i> spp. (Lam.)	Rhamnaceae
Indian Sunbeam	<i>Curetis thetis</i>	<i>P. pinnata</i>	Fabaceae
Dark Pierrot	<i>Tarucus ananda</i>	<i>Ziziphus</i> spp	Rhamnaceae
Rounded Pierrot	<i>Tarucus nara</i>	<i>T. procumbens</i>	Asteraceae
Plains Cupid	<i>Chilades pandava</i>	<i>Bauhinia vahlii</i> (Linn.)	Fabaceae
Lime Blue	<i>Chilades lajus</i>	<i>C. maxima</i>	Rutaceae
Plains Cupid	<i>Chilades pandava</i>	<i>Cycas revolute</i> (Thunb.)	Cycadaceae
Grass Jewel	<i>Freyeria trochylus</i>	<i>Oxalis corniculata</i> (Linn.)	Oxalidaceae
Transparent 6-Lineblue	<i>Nacaduba kurava</i>	<i>Embelia robusta</i> (Burm.)	Primulaceae
Quaker	<i>Neopithecops zalmora</i>	<i>Glycosmis arborea</i> (Retz.)	Rutaceae

calycinum, *Castalius rosimon* lays egg on *Ziziphus jujube* and *Rathinda omor* lays exclusively on *Ixora* spp and this coincides with *Curetis thetis* lays on *Pongamia glabara* only.

Nimbalkar et al (2011) reported that the herbs namely, *Celosia argentea*, *T. procumbens* and *T. purpurea* were more used by butterflies probably due to the act that the flowering

Table 8. Important nectar food plants of lycaenid butterfly species (2017-2018)

Common name	Scientific name	Nectar yielding plant species
Apefly	<i>Spalgis epius</i>	<i>L. camara</i>
Common Acacia Blue	<i>Surendra quercetorum</i>	<i>Trifolium repens</i> , <i>T. procumbens</i>
Indian Sunbeam	<i>Curetis thetis</i>	<i>P. pinnata</i> (Linn.), <i>L. camara</i>
Large Oakblue	<i>Arhopala amantes</i>	<i>Kalanchoe laciniata</i> (Adans.)
Indian Oakblue	<i>Arhopala atrax</i>	<i>Ziziphus</i> spp., (Lam.), <i>Achyranthes aspera</i> (Linn.)
Grass Jewel	<i>Freyeria trochylus</i>	<i>Flacourtia indica</i> (Burm. f.)
Bright Babul Blue	<i>Azanus ubaldus</i>	<i>Crotalaria capensis</i> (Linn.)
Transparent 6-Lineblue	<i>Nacaduba kurava</i>	<i>Ixora</i> spp, <i>T. purpurea</i>
Quaker	<i>Neopithecops zalmora</i>	<i>Ziziphus</i> spp. <i>Celosia argentea</i> (Linn.)
Tailless Line Blue	<i>Prosotas dubiosa</i>	<i>Ziziphus</i> spp. <i>T. procumbens</i>
Common Red Flash	<i>Rapala iarbus</i>	<i>Saraca asoca</i> (Roxb.), <i>Z. mauritiana</i> .
Leaf Blue	<i>Amblypodia anita</i>	<i>Meyna pubescens</i> (Roxb.)
Yamfly	<i>Loxura atymnus</i>	<i>Rumex</i> spp. (Linn.), <i>T. procumbens</i>
Common Onyx	<i>Horaga onyx</i>	<i>Shorea robusta</i> (Roth), <i>Ziziphus</i> spp
Common Tinsel	<i>Catapaecilma elegans</i>	<i>Z. jujube</i> (Mill.), <i>Z. mauritiana</i>
Common Pierrot	<i>Castalius rosimon</i>	<i>Parthenium hysterophorus</i> (Linn.)
Angled Pierrot	<i>Caleta caleta</i>	<i>Ziziphus</i> spp.
Common Pierrot	<i>Castalius rosimon</i>	<i>Cynotis villosa</i> (Spreng.)
Banded Blue Pierrot	<i>Discolampa ethion</i>	<i>L. camara</i> , <i>T. procumbens</i>
Zebra Blue	<i>Leptotes plinius</i>	<i>C. argentea</i> , <i>T. procumbens</i>
Common Line Blue	<i>Prosotas nora</i>	<i>Acacia torta</i> (Roxb.), <i>Bidens pilosa</i> (Linn.)
Dark Cerulean	<i>Jamides bochus</i>	<i>L. camara</i> , <i>T. purpurea</i>
Common Cerulean	<i>Jamides celeno</i>	<i>C. argentea</i> , <i>L. camara</i>
Pea Blue	<i>Lampides boeticus</i>	<i>C. argentea</i> , <i>P. pinnata</i>
Rounded Pierrot	<i>Tarucus nara</i>	<i>Ziziphus</i> spp., <i>Aegle marmelos</i> (Linn.)
Dark Pierrot	<i>Tarucus ananda</i>	<i>Ziziphus</i> spp., <i>Murraya koenigii</i> (Linn.)
Dark Grass Blue	<i>Zizeeria karsandra</i>	<i>L. camara</i>
Pale Grass Blue	<i>Pseudozizeeria maha</i>	<i>T. purpurea</i> , <i>C. argentea</i> ,
Tiny Grass Blue	<i>Zizula hylax</i>	<i>L. camara</i>
Indian Cupid	<i>Everes lacturnus</i>	<i>B. pilosa</i> , <i>Capparis rheedii</i> (Linn.)
Red Pierrot	<i>Talicauda nyseus</i>	<i>T. procumbens</i> , <i>Capparis zeylanica</i> (Linn.)
Gram Blue	<i>Euchrysops cnejus</i>	<i>L. camara</i> , <i>Ixora</i> spp
Plains Cupid	<i>Chilades pandava</i>	<i>Galinsoga parviflora</i> (Cav.)
Lime Blue	<i>Chilades lajus</i>	<i>Urena lobata</i> (Linn.), <i>Crotalaria capensis</i> (Linn.)
Plain Hedge Blue	<i>Celastrina lavendularis</i>	<i>Emilia sonchifolia</i> (Linn.)
Grass Jewel	<i>Freyeria trochylus</i>	<i>Rumex</i> spp., <i>T. procumbens</i>
Pale Hedge Blue	<i>Udara dilecta</i>	<i>S. robusta</i> , <i>Ziziphus</i> spp
Transparent 6-Lineblue	<i>Nacaduba kurava</i>	<i>Z. jujube</i> , <i>Z. mauritiana</i>
Quaker	<i>Neopithecops zalmora</i>	<i>P. hysterophorus</i>
Common Tinsel	<i>Catapaecilma elegans</i>	<i>Z. mauritiana</i> , <i>T. procumbens</i>

period of these herbs is throughout the year. The shrubs namely, *Calotropis gigantean* and *Lantana camara* also had a flowering period throughout the year. Hence, they are most used by butterflies as their food plants. Kanagaraj and Kathirvelu (2018) reported 20 plant species belong to Fabaceae, Rhamnaceae, Amaranthaceae, Zygophyllaceae, Acanthaceae, Oxalidaceae, Smilacaceae, Olacaceae and Combretaceae families in Annamalainagar. Among them, Fabaceae family was predominant with major larval host plants of lycaenids of Annamalainagar. The lycaenid populations were recorded at the time when the host plants in suitable phenophase for growth of the caterpillars. Kunte (2000) reported that important larval food plants of Lycaenidae were *Butea monosperma*, *Crotalaria* spp., *Millettia peguensis*, *Vigna cylindria*, *P. pinna* and *Xylia xylocarapa*. Pale et al (2015), they reported that the Pea Blue butterfly is known to feed on many Fabaceae plants including several *Crotalaria* spp, and the present study clearly indicated that the *Vigna trilobata* was the most desirable plant for oviposition of this lycaenid butterflies. Further, Kathirvelu and Gopianand (2023) reported the *Lampides boeticus* was very common in agro-ecosystem.

Plant species pollinated by lycaenid butterflies and nectar yielding plants: Among the 34 plant species benefited from butterflies, the plants belong to the families namely, Verbenaceae was pollinated by many species of lycaenid butterflies (Table 7). Most lycaenids were attracted to flowers with yellow/ white/ reddish in colour. Thakur and Mattu (2010) also reported that the flowers of family Asteraceae were most attracted to various butterfly species. The flowers of the family Mimosaceae, Dioscoreaceae, Lauraceae, Rubiaceae, Melastomataceae, Myrtaceae, Rhamnaceae, Zingiberaceae, Fabaceae, Oxalidaceae, Rutaceae were attracted many lycaenid butterflies as reported by Bora and Meitei (2014). The nectar yielding plants species (40) of the study area were identified as *Zizyphus* spp., *Lantana camara*, *Celosia argenta*, *Tridax procumbens*, *Tephrosia purpurea*. Most of the lycaenid butterfly species were depend on *Zizyphus* spp., *T. procumbens*, *C. argentea*, *Saraca asoca*, *Parthenium hysterophorus* and *Bidens pilosa* for their nectar food in the study area (Table 8). The butterfly species observed in the study area were strongly associated with the plants of the family Fabaceae, both as the caterpillars and adults. Sultana et al. (2017) observed that the lycaenids are small sized butterflies with small proboscis. They chose flowers having similar and nearly similar corolla tube length compare to their proboscis length.

CONCLUSION

The lycaenids showed their strong mutualistic behaviour with ants for their survival in the environment by benefitting

each other. The larval response in delivering the honey dew droplets is proportional to the degree of ants attended. Colourational change revealed that there were two forms viz., WSF and DSF differentiated with markings and spots. Places near to water bodies or damp area was preferred by the lycaenids for mud puddling and the wing position of the butterflies were found with wing upright and adpressed position while at rest than other positions. Totally 64 plant species were observed as host plants of lycaenids in which Fabaceae, Rhamnaceae and Combretaceae were most preferred. The plant species belong to Verbanaceae was most benefitted by pollination service of lycaenids and they were well attracted to yellow, white and red colour. Most of the lycaenid butterfly species were depend on *Zizyphus* spp., *T. procumbens*, *C. argentea*, *Saraca asoca*, *Parthenium hysterophorus* and *Bidens pilosa* for their nectar food in the study area. The lycaenids were diversified in the study area and had a multiple dimension as predator, pest, pollinator and also their protective behaviours by having mutualistic association with ants. Further, they are successful in reproduction with their behaviours like puddling and change their forms according to the seasons for survival.

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