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Patterns of Seasonality in the flight and early stages of some south Indian butterfly Species

Bodapati Samatha[1], Matala Bhupathi Rayalu[2*]
[1] Department of Botany, Andhra University, Visakhapatnam-530 003, Andhra Pradesh, India.
[2] Assistant Professor (Senior), Department of Botany, Government Degree College, Razole, East Godavari, Andhra Pradesh, India

Abstract
Based on a field study of monitoring the adults in flight, and the early stages on the larval host plants in their natural habitat on the Andhra University campus at Visakhapatnam (17^0 42'N - 83^0 20'E), the flight and reproductive periods of eleven butterfly species are presented. The climate is of tropical monsoon type with summer (March-May), rainy or southwest monsoon (June-September), northeast monsoon (October–November) and winter (December-February) seasons. Five species *Elymnias hypermnestra, Ariadne merione, Junonia hierta, Lampides boeticus* and *Leptosia nina* had their adults in flight throughout the year, and the others *Melanitis leda, Mycalesis subtida, Hypolimnas bolina, H. misippus, Talicada nyseus* and *Pareronia valeria* during specific periods of the year: September-March, July-May, July-March, July-February, January-May, and November-March respectively. Seasonal peaks of abundance were evident with all the species excepting *P. valeria* whose population was small. Only *A. merione* and *T. nyseus* reproduced throughout the flight period as evidenced by the occurrence and distribution of early stages. Others had some reproductively inactive flight period or sexual diapause, which varied in length from 1- 8 months depending on the species. The periods of higher frequency of adults corresponded well with the periods of higher reproduction of respective species. Such peaks occurred during SW monsoon for *A. merione*, mid SW (August-September) - NE monsoon for *H. bolina, H. misippus, L. boeticus* and *J. hierta*, NE monsoon for *M. leda* and *M. subtida*, winter-summer for *E. hypermnestra* and *T. nyseus,* and winter for *L. nina*. Thus there was no uniform picture of seasonality for all the eleven butterfly species of the study. Each of the eleven butterfly species might have evolved its own lifestyle vis-à-vis, seasonal pattern in flight and reproduction in response to a certain combination of the prevailing environmental factors in a region.

Keywords: seasonal peaks, flight, sexual diapauses, reproductive periods, Andhra University

1. Introduction

Very distinct climatic seasons exist in regions of higher latitudes where butterfly activity is severely limited by severe winter conditions. On the other hand, in the tropics climate is less seasonal, a fairly high temperature prevails throughout the year, and most 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 indicate also the seasonal cycles in their reproduction. Thus the breeding season is assumed to follow closely the flight period both in time and intensity. But it is being realized that counts of early stages are the better indicators of population size than adult counts. Further, information on the seasonality of early stages of Indian butterflies is almost virtually lacking but such data are required for proper conservation and management of butterflies. We describe here the seasonality in eleven species of butterflies based on simultaneous measurements of both adults and early stages (eggs, larvae and pupae put together).

Materials and Methods

The study was made during the period spanning over three years 2012 to 2014 at the Andhra University campus at Visakhapatnam ($17^0$42`N - $83^0$20`E), Andhra Pradesh, Southern India. The campus spreads over an area of 168 hectares in proximity to the coastline, and maintains wild patches of vegetation with secondary growth. A belt transect approximately 750 m 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 through the length of the transect was undertaken at 10-day intervals. The butterflies in the study biotope were found active during 0830-1500 h; hence walks were made during those hours, mostly between 0900-1130 h. While walking, the relative abundance of adults was recorded by an arbitrary index as rare, common and very common. Also the early stages on the chosen larval host plants in the transect were searched and enumerated. Previous acquaintance with the early stages of each of the 11 butterfly species in a study of life history in the laboratory facilitated their accurate recognition and enumeration. The food resources of the adult butterflies along with the flowering period of floral nectar resources were recorded.

The number of oviposition host plants included in the searches for early stages depended on their size and density as: *Areca catechu* (horticultural variety) 20 plants for the common palmfly *Elymnias hypermnestra* Linnaeus; *Brachiaria distachya* 2 patches (each about a square meter in size) for the common evening brown *Melanitis leda* Linnaeus; another 2 patches of the same host for the Tamil bushbrown *Mycalesis subtida* Moore; *Ricinus communis* 10 plants for the common castor *Ariadne merione* Cramer; *Sida veronicaefolia* 15 plants for the great eggfly *Hypolimnas bolina* Linnaeus; *Asystasia gangetica* 10 plants for the danaid eggfly *Hypolimnas misippus* Linnaeus; *Barleria prionitis* 10 plants for the yellow pansy *Junonia hierta* Fabricius; *Crotalaria laburnifolia* 4 plants for the pea blue *Lampides boeticus* Linnaeus; *Kalanchoe pinnata* 30 plants for the red pierrot *Talicada nyseus* Guerin-Meneville; *Capparis spinosa* 4 plants for the psyche *Leptosia nina* Fabricius and also for the common wanderer *Pareronia valeria* Cramer. In the case of *L. boeticus*, the 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.

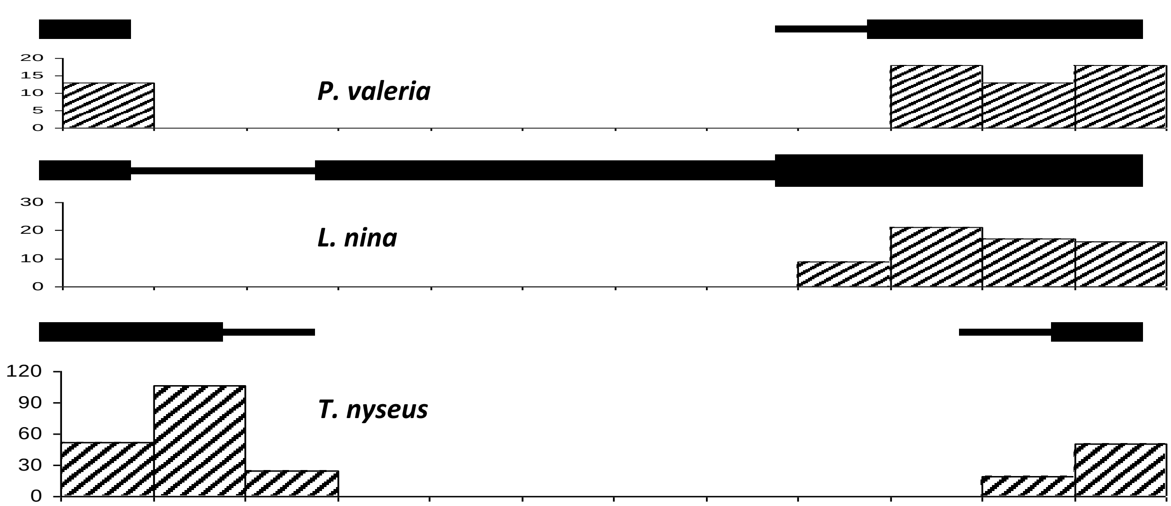
Table 1: Monthly Mean temperature, relative humidity, rainfall and the length of photoperiod for the years 2012-2014 at Visakhapatnam, Andhra Pradesh, India

Month	Temp (°C)		RH (%)		Total rainfall (mm)	Photo-period (hours)
	Max	Min	0830	1730		
Jan	27.74	20.14	74.0	69.7	006.70	1212
Feb	29.26	22.18	72.4	70.2	004.10	1234
Mar	31.34	24.56	72.6	73.6	014.01	1303
Apr	32.12	26.42	70.6	77.4	044.56	1333
May	33.52	27.90	70.3	74.8	024.08	1357
Jun	32.98	27.42	73.4	73.6	083.22	1412
Jul	32.00	26.50	78.2	77.8	138.50	1404
Aug	31.48	26.02	77.8	78.6	099.96	1342
Sep	31.88	26.06	78.0	78.6	226.44	1313
Oct	30.88	24.92	78.2	78.6	317.96	1244
Nov	29.68	22.52	65.4	64.7	072.76	1219
Dec	28.38	20.46	65.6	64.4	018.12	1205

Source: Indian Meteorological Department (IMD) located at 400m away from the study locality.

Results

Of the eleven butterfly species studied, the adults of only five species *E. hypermnestra*, *A. merione*, *J. hierta*, *L. boeticus* and *L. nina* were encountered in all months of the year with distinct seasonal peaks of abundance respectively occurring during December - April, June - September, August - October, August - December, and November - February (Fig. 1). The other six species exhibited restricted flight periods; *M. leda* September - March, *M. subtida* July - March, *H. bolina* July - March, *H. misippus* July-February, *T. nyseus* January-May and *P. valeria* November-March. Even these species of limited temporal distribution had discernible peaks of population abundance, excepting *P. valeria* the population of which was of very low density. There was complete correspondence of the periods of higher frequency of adults with the frequency of early stages. But only two species *A. merione* and *T. nyseus* reproduced throughout their flight period. The other nine species were reproductively inactive through part of their flight period. This period of sexual diapause was rather long: 8 months (March-October) for *L. nina*, 5 months (January-May) for *J. hierta*, 4 months (June-September) for *E. hypermnestra*, 3 months (April-June) for *L. boeticus*, 3 months (February-March; July) for *H. bolina*, 2 months (February-March) for *M. leda* and for *M. subtida*, one month (July) for *H. misippus*, and one month (November) for *P. valeria*. The butterflies that undergo sexual diapause as adults live longer than those that do not. The differential longevity of such adults becomes an important aspect of seasonality.



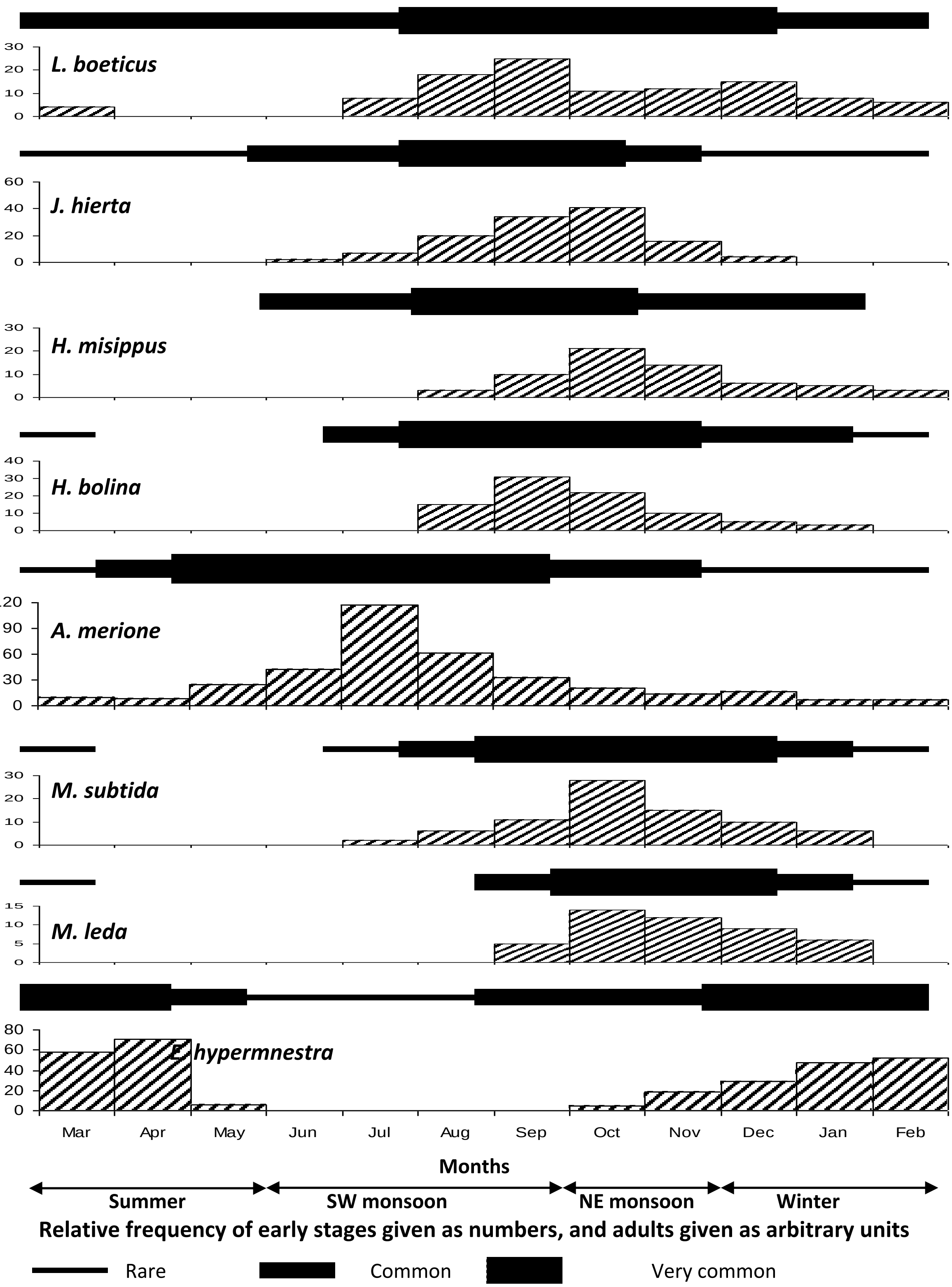


Fig 1: Month-wise distribution of early stages (histograms) and adults (shaded lines) of eleven butterfly species at Visakhapatnam

Discussion

The distribution and relative frequency of butterflies over time is usually correlated with the temporal availability of host plants of larvae and adults as well and local rainfall distribution and temperature (Wynter-Blyth 1957, Owen 1971 & Kunte 2000) [1, 2, 3]. There was year round presence of some nectar resources needed by the nectar seeking butterfly species under study (Table 2 and 3). The oviposition and larval plants mentioned earlier were also available in all the months of the year for seven species *E. hypermnestra*, *A. merione*, *J. hierta, L. nina, P. valeria*, *L. boeticus*, and *T. nyseus.* If the two satyrids *M. leda* and *M. subtida* are treated as opportunistic using whatever grass species available for ovipositioning and as larval hosts (Braby 1995) [4], they also should not have any limitation for oviposition and larval food plants because some grass species was available in the biotope of the study at any time of the year. Similarly, if all the recorded larval host plants of the two eggfly species *H. bolina* and *H. misippus* (Sevastopulo 1973) [5] were taken into consideration, there should be also no limitation for larval feeding and thus for reproduction. In spite of the yearlong availability of food plants, only five species had yearlong flight period and the flight of other six species was limited to particular periods of the year. It thus appears that in the study biotope the flight and reproductive periods, and thS peaks of abundance of the butterfly species might be largely governed by the amount and distribution of rainfall, and the temperature variations through the year. Wynter-Blyth (1957) [1] stated that in south India, the best months for butterflies depend on local rainfall distribution.

The weather data borrowed from the India Meteorological Department at Visakhapatnam 400 meters away from the study site are given in Table 1. IMD recognizes four climatic seasons during a year: summer March-May, rainy or southwest monsoon June-September, northeast monsoon October-November, and winter December-February. The rainfall was rather heavy during June-November due to the overlapping SW and NE monsoons (Table 1). 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 moderate. Cold conditions developed from December and continued till the end of February. The difference between maximum and minimum temperature was below 10ºC in any month. Analysis of the flight period in relation to these climatic seasons showed that among the six seasonal species, *H. misippus*, *H. bolina* were more frequent during mid SW-NE monsoons, *M. leda* and *M.subtida* during NE monsoon. *T. nyseus* during winter-summer and *P. valeria* during late NE monsoon-early summer. The two satyrids *M. leda* and *M. subtida* found seasonally in the present study were reported in abundance throughout the year in dense forests of Silent Valley with typical humid tropical rain forest (Mathew & Rahamathulla 1993) [6]. Probably these satyrids require more moist and shady conditions 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: *A. merione* SW monsoon (May also received good rains during the assessment period promoting abundance), *J. hierta* and *L. boeticus* mid SW and NE monsoon, *E. hypermnestra* winter-summer and *L. nina* winter months. The breeding activity was high during SW monsoon for *A. merione,* mid SW-NE monsoon for *H. bolina*, *H. misippus*, *L. boeticus* and *J. hierta*, NE monsoon for *M. leda* and *M. subtida*, winter - summer for *E. hypermnstra* and *T. nyseus*, and winter for *L. nina*. High rate of wet season breeding of *H. bolina* and *H. misippus* was also reported in Sierra Leone (Africa) (see Smith 1984) [7] and in Australian wet–dry tropics (Kemp 2001) [8]. Thus the period of monsoons (SW-NE) appear to be relatively more favourable for most butterfly activity. This is almost similar to the pattern of flight activity of the butterflies in less seasonal, relatively dry forests of northern Western Ghats where it was reported to be high during late monsoon (August-September) and early winter (October-November) (Kunte 1997; 2000) [9, 3]. However, the summer months are not altogether detrimental to butterfly activity. The dry season favored high rate of reproduction in *E. hypermnstra* and *T. nyseus.* Such dry season highs in butterflies reproduction is not uncommon: *Graphium policenus* (Owen 1971) [2], *G. doson* (Venkataramana *et al*. 2002) [10], *Acraea terpsicore* (Subba Reddi *et al*. 2002) [11], *Anaphaeis aurota* (Venkataramana *et al*. 2003) [12], *Pachliopta aristolochiae* (Atluri *et al.* 2004) [13]. Such summer increases support Wynter-Blyth (1957) [1] who stated that the spring or *vasanth rithu* or early part of summer is most favourable for butterflies, if not for all, at least for some butterflies. Under temperate conditions as in Britain, warm, dry seasons are generally beneficial to the abundance of butterflies (Pollard 1988) [14]. The ‘seasonal ecotone’ effect promoting the abundance of butterflies due to overlapping of dry - and wet - season species observed by Emmel & Leck (1969) [15] in the tropical rain forest butterfly populations in Panama is not evident in the distribution of the eleven butterfly species under study.

Some researches showed that the initiation and continuation of reproduction is under the direct control of rainfall (Christopher & Mathavan 1986) [16]. At Madurai (South India) the pierid butterfly *Catopsilia crocale* was reported to undergo a 100-120 days of reproductively inactive period. Its breeding activity begins with the start of southwest monsoon from April and continues through August, reaches a high frequency during the northeast monsoon (September-December). Breeding activity ceases at the end of northeast monsoon, and the adults emerged at this time survived till the beginning of the following southwest monsoon when they begin to reproduce. Though the periods of higher reproduction of five of the eleven species under study coincided with the monsoon period, the kind of response observed for *C. crocale* is not evident with any of the eleven butterfly species. Even another species of *Catopsilia*, *C. pyranthe* from the present study biotope was shown to be a continuous breeder irrespective of the pattern of distribution of monsoon rains (Atluri *et al*. 2004) [17]. Also, the danaines *Euploea core* and *Danaus chrysippus* reported by Larsen (1985) [18] to undergo sexual diapause in their dry season aggregations in the Corbett National Park and begin to breed with the onset of monsoon rains in late June were reported to breed continuously in the study biotope (Venkataramana *et al.* 2001; 2003) [19, 20].

Reproductive seasonality of butterflies may also depend on photoperiod (Owen 1971; Kunte 2000) [2, 3]. The length of daylight in the study area varied between a high of 1412 h in June and a low of 1205 h in December (Table 1). It was relatively long during March-September, and only a little longer than the nights during October-February. Since different species exhibited different seasonalties with high rates of reproduction in different periods, the prevailing length of day does not appear to be critical for reproduction in the study locality. Studying the effect of environmental conditions on mating activity of *Precis coenia*, McDonald & Nijhout (2000) [21] found that a right combination of light level and temperature during the day induced courtship and mating activity.

Conclusion

It can be presumed that different combinations of different factors like rainfall, dew, temperature, light intensity and photoperiod may influence differently the different butterfly species. The flight and reproductive behaviour of the eleven species attest to such assumption and suggest that each species has evolved its own lifestyle pattern in association with the prevailing environment of the overlapping climate seasons, thus complying with the axiom of the theory of evolution that ecological differences exist between species however closely they are related.

Table 2: Floral nectar resources of butterflies and flowering periods in the study area

S.No.	Name of plant species	Floral months	S.No.	Name of plant species	Floral months
1	*Anacardium occidentale*	12 - 3	21	*Hyptis suaveolens*	8 - 1
2	*Antigonon leptopus*	1 - 12	22	*Ixora arborea*	1 - 12
3	*Asystasia gangetica*	1 - 12	23	*I. cinerea*	1 - 12
4	*Blepharis maderaspatensis*	1 - 12	24	*Justicia procumbens*	6 - 10
5	*Boerhavia diffusa*	6 - 12	25	*Lantana camara*	1 - 12
6	*Borreria hispida*	6 - 11	26	*Merremia tridentate*	8 - 10
7	*Bougainvillea spectabilis*	1 - 12	27	*Oldenlandia corymbosa*	7 - 10
8	*Caesalpinia coriaria*	7 - 9	28	*Portulaca quadrifida*	7 - 10
9	*C. pulcherrima*	1 - 12	29	*Pupalia lappacea*	7 - 10
10	*Catharanthus roseus*	1 - 12	30	*Santalum album*	6 - 10
11	*Cestrum diurnum*	6 - 12	31	*Sapindus emaginatus*	10 - 12
12	*Clerodendrum viscosum*	5 - 9	32	*Sida acuta*	8 - 12
13	*Corchorus acutangulus*	7 - 10	33	*S. cordifolia*	8 -12
14	*Cosmos sulphureus*	1 - 12	34	*S. veronicaefolia*	8 - 12
15	*Croton bonplandianus*	1 - 12	35	*Tagetus patula*	7 - 10
16	*Duranta repens*	6 - 12	36	*Tephrosia purpurea*	1- 12
17	*Evolvulus alsinoides*	7 - 10	37	*Tribulus terrestris*	6- 10
18	*Gliricidia sepium*	11 - 1	38	*Tridax procumbens*	1- 12
19	*Gomphrena globosa*	7 - 10	39	*Triumfetta pentandra*	7- 10
20	*Hybanthus enneaspermus*	1 - 12	40	*Vernonia cinerea*	1 - 12

Table 3: Butterfly species, their larval and floral hosts

Butterfly species	Larval host plants	Floral host plants (Serial number in Table-1)
Satyridae		
Elymnias hypermnestra	*Areca catechu, Cocos nucifera*	Non-nectarivorous
Melanitis leda	*Brachiaria distachya*	Non-nectarivorous
Mycalesis subtida	*Brachiaria distachya*	Non-nectarivorous
Nymphalidae		
Ariadne merione	*Ricinus communis*	Non-nectarivorous
Hypolimnas bolina	*Sida veronicaefolia*	2,11,25,30
H. misippus	*Asystasia gangetica, Portulaca quadrifolia*	1,2,21,25,30,31,35
Junonia hierta	*Asystasia gangetica, Barleria prionitis, Dipteracanthus prostratus, Ruellia tuberosa.*	2,8,9,13,16,25,30,35,38
Lycaenidae		
Lampides boeticus	*Crotalaria laburnifolia*	2,6,13,14,16,18,19,23,24, 26,29,32,33,34,36,37,38,39,40
Talicada nyseus	*Kalanchoe pinnata*	13,15,18,38
Pieridae		
Leptosia nina	*Capparis spinosa*	4,5,17,20,24,27,28,32,34,38,40
Pareronia valeria	*Capparis spinosa*	3,7,10,12,22

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References

1. Wynter-Blyth MA. Butterflies of the Indian region. The Bombay Natural History Society, Bombay, India 1957.
2. Owen DF. Tropical Butterflies. Clarendon Press, Oxford 1971.
3. Kunte K. Butterflies of Peninsular India. Universities Press (India) Ltd., Hyderabad, India 2000.
4. Braby, MF. Larval and adult food plants for some tropical Satyrine butterflies in northern Queensland. Australian Entomologist. 1995; 22:5-13.
5. Sevastopulo DJ. The food plants of Indian Lepidoptera. Journal of the Bombay Natural History Society. 1973; 70:156-183.
6. Mathew G, Rahamathulla VK. Studies on the butterflies of Silent Valley National Park. Entomon. 1993; 8:185-192.
7. Smith DAS. Mate selection in butterflies: Competition, Coyness, Choice, and Chauvinism. In: The Biology of Butterflies. Ed. By Vane-Wright RI, Ackery PR. Academic Press, London, 1984, 225-244.
8. Kemp DJ. Reproductive seasonality in the tropical

butterfly *Hypolimnas bolina* (Lepidoptera: Nymphalidae) in northern Australia. Journal of Tropical Ecology. 2001; 17: 483-494.

9. Kunte K. Seasonal patterns in butterfly abundance and species diversity in four tropical habitats in northern Western Ghats. Journal of Bioscience. 1997; 22:593-603.
10. Venkataramana SP, Atluri JB, Subba Reddi C. Autecology of common jay butterfly *Graphium doson* (Lepidoptera: Rhopalocera:Papilionidae. Indian Journal of Environment and Ecoplanning. 2002; 6:10-08.
11. Subba Reddi C, Venkataramana SP, Atluri JB. Ecobiology of the Tawny Coster *Acraea terpsicore* (Lepidoptera: Rhopalocera: Papilionidae). Annals of Entomology. 2002; 20:29-34.
12. Venkataramana SP, Atluri, JB, Subba Reddi C. Ecobiology of caper whitebutterfly *Anaphaeis aurota* (Lepidoptera: Rhopalocera: Pieridae). Proceedings of the Andhra Pradesh Akademi of Sciences. 2003; 7:291-296.
13. Atluri JB, Venkataramana SP, Krishna Reddi D, Subba Reddi C. Ecobiology of the common rose butterfly *Pachliopta aristolochiae* (Lepidoptera: Rhopalocera: Papilionidae Proceedings of the Andhra Pradesh Akademi of Sciences. 2004; 8:147-154.
14. Pollard E. Temperature, rainfall and butterfly numbers. Journal of Applied Ecology. 1988; 25:819-828.
15. Emmel TC, Leck CF. Seasonal changes in organization of tropical rain forest butterfly populations in Panama. Journal of Research on the Lepidoptera. 1969; 8:133-152.
16. Christopher MSM, Mathavan S. Population dynamics of a tropical lepidopteran *Catopsilia crocale* (Pieridae). Proceedings of the Indian Academy of Sciences (Animal Science. 1986; 95:303-324.
17. Atluri JB, Venkataramana SP, Subba Reddi C. Ecobiology of *Catopsilia pyranthe*, a tropical pierid butterfly. Current Science. 2004; 86:457-461.
18. Larsen TB. A dry season aggregation of danaine butterflies in Corbett National Park (Lepidoptera: Nymphalidae: Danainae). Journal of the Bombay Natural History Society. 1985; 83:456-458.
19. Venkataramana SP, Atluri JB, Subba Reddi C. Autecology of the common crow butterfly. Ecology Environment and Conservation. 2001; 7:47-52.
20. Venkataramana SP, Atluri JB, Subba Reddi C. Autecology of the plain tiger butterfly *Danaus chrysippus* (Lepidoptera: Rhopalocera:Danaidae). In: Environment, Pollution and Management. Ed. by Kumar A, Bohra C, Singh LK. A.P.H. Publishing Corporation, New Delhi, India. 2003: 551-561.
21. Mcdonald AK, Nijhout, HF. The effect of environmental conditions on mating activity of the Buckeye butterfly, *Precis coenia*. Journal of Research on the Lepidoptera 2000; 35:22-28.