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Studies on diversity, seasonality, habitat and host plant specificity of butterflies (Family:Papilionidae) in the Nilgiri hills, Southern western ghats, Tamilnadu, India

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Abstract

Survey was conducted from March 2012 to February 2014 by using line transect method in Nilgiri hills. A total of 18 species of butterflies belonged to the family papilionidae were recorded. The study of seasonal variation revealed that 18 species were recorded throughout the year. Greatest species diversity was recorded during post monsoon. Monthly ûuctuation in diversity was influenced by rare species. Most of the species prefer semi evergreen and evergreen forest for their habitats. Larvae of papilionidae fed mostly the leaves of *Aristolochia, Cinnamomum, Annona, Polyalthia, Citrus, Glycosmis, Murraya, Atalantia, Cinnamomum* and *Toddalia* species. Nectar bearing plants were also recorded from the Nilgiri hills for the adult papilionidae species. Most of the papilionidae species collected the nectar from the *Lantana* plant.

Key words: Butterflies, Papilionidae, diversity, seasonal, habitat, larval host plants, nectar plants

INTRODUCTION

The swallowtail butterfly family Papilionidae includes 550 species, most of them are large, colourful and recognizable even to non-specialists. While the majority of swallowtail species are found in tropical latitudes, representatives of the family can be found in every continent except Antarctica, and can also common in both tropical and temperate countries. Swallowtail butterfly diversity is greatest in East and Southeast Asia, a region where many natural butterfly habitats are under extreme threat of destruction due to human activity. Some swallowtails, particularly representatives from the genus *Parnassius*, capable of flying to very high elevations. The birdwing butterflies (Troidini: *Troides*) of Australasia are the largest butterflies in the world. Collins and Morris (1985) reviewed the patterns of swallowtail diversity around the world.

The name "swallowtail" refers to a tail-like extension on the edge of the hind wing that is found in many, though not all, papilionids. The function of this tail is not known, but genetic studies in some species of *Papilio* suggest the tail is a labile character whose expression is controlled by a single gene (Clarke and Sheppard, 1960, Clarke *et al*., 1968). About 84 species are found in India (Häuser *et al*., 2005; Reed *et al*., 2006). Two of the three papilionid subfamilies are represented in India, namely, the Parnassiinae, or 'Apollos', with 14 species, and, the Papilioninae, or 'Swallowtails', with 70 species.

The larvae of Papilionidae mostly utilize the leaves of five families namely Aristolochiaceae, Annonaceae, Lauraceae, Apiaceae and Rutaceae. Notably, the swallowtail tribes Zerynthiini (Parnassiinae), Luehdorfiini (Parnassiinae) and Troidini (Papilioninae) exclusively feed on Aristolochiaceae, which provides aristolochic acids that make both the larval and adult stages unpalatable to predators (von Euw *et al.,* 1968). Adults feed on nectar from a variety of flowers. The adult butterfly uses its long proboscis (tongue) to collect nectar from flat-topped flowers such as milk parsley and thistle Swallowtails mate during the summer months, from late May onwards and the eggs are laid singly on the upper leaves of the milk parsley. They hatch after about two weeks and at first the tiny caterpillars look like bird droppings. When fully grown they become an attractive green with a black and orange stripes.

The species of swallowtails are worth preserving, not only for its beauty but also the Indian swallowtails are unique subspecies found nowhere else in the world. The swallowtail's future in the Nilgiri hills seems secure, at least for the time being. The present article deals with the diversity, seasonal variation, habitat and host plant preference of butterflies in Nilgiri hills.

MATERIALS AND METHODS

Diversity of Butterflies

Survey of butterflies, family papilionidae is carried out in different habitats in Nilgiri hills. In each habitat type, two transects have been laid across the habitat, so as to cover all features of the habitats. The length of each transect was 2 km. Butterflies were observed up to 20 m on both sides of transects. Observations were made for the entire transects (2,000 m). Transects were away from the influence of edges and ecotones and well within the vegetation types. Areas of major disturbances were avoided.

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In the 2 km transect line; all the butterfly species were counted. Ocular observations were made. The key characters used for identification were colour pattern, wing span, mode of flight, etc. No collection of specimens was done. During the study, flight patterns, activity patterns and behaviour were also noted. The observations were made between 7 am to 10 am for a period, covering the four seasons viz., winter (December, January, February), summer (March, April and May), southwest monsoon season (June, July and August) and northeast monsoon season (September, October and November). All the species of butterflies chosen for the study were counted in different months and seasons. During the survey, their perpendicular distances from the transect lines and the heights at which they have seen first, as well as the date, time, and general weather conditions were recorded.

Identification of Butterfly Species:

Identification of the butterflies, family papiliondiae was primarily made directly in the field. In critical condition, butterflies were photographed/recorded with digital camera and identification was made with the help of standard manuals (Wynther-Blyth, 1957; Kunte, 2000; Gunathilagaraj, 1998) and specialist.

RESULTS AND DISCUSSION

A total of 18 species of butterflies belonged to the family papilionidae were identified. The diversity of species recorded with families is given in the Table 1. About 105 species of swallowtails (Papilios), out of the world's 700, are found in India, and among them 19 species are present in peninsular India. Eighteen species have been reported in the present study area, which includes the India's largest butterfly, Southern Bird Wing (*Triodes minos*), endemic to peninsular India. The family also includes two other species (Crimson Rose and Blue Mormon) which are endemic to Western Ghats and Sri Lanka. Lime butterfly (*Papilio demoleu*s) of this family was found most abundant in this study area whereas 3 other species were found rare

The distribution of the butterflies showed that they were seasonal in their occurrence. They were common for only a few months and rare or absent in other parts of the year as reported by Kunte (2000). Seasonal variations in species richness of papilionidae was observed during the study and is presented in the Table 2 . Obviously more number of butterfly species was encountered during monsoon, which increased in post monsoon and decreased during winter and summer. However, all the species of papilionidae were recorded throughout the year from Nilgiri hills. Butterflies are sensitive to the changes in the habitat and climate, which influence their distribution and abundance (Winter-Blyth, 1957).

In general, the phenological patterns found in this study are similar to those described by de la Maza and de la Maza (1985a, b) and Austin *et al*. (1996), with peak butterfly diversity at the end of the dry season and another peak during the rainy season. Reduced species diversity was observed from the end of the rainy season to the middle of the dry season. Forty butterfly species have been recorded throughout the year; similarly, Austin *et al*. (1996) reported 10% of the butterfly fauna throughout the year from the Tikal area, Guatemala.

Maximum species diversity was observed during the months of October and November which is in agreement with previous studies reported from México (Vargas-Fernández *et al*., 1992, 1999). This period coincides with the end of the rainy season. The 2 peaks in species richness coincide with the greatest relative abundance. The largest peak was observed from January to November, which corresponds to the rainy season. However, there were only few species recorded during September. The small peak was observed from March to May. Diversity of Papilionidaewas was peak during the late dry season and into the early rainy season, as reported by Austin *et al*. (1996) from the Tikal area. Irregular pattern of relative abundance of Papilionidae was recorded throughout the year, but the greatest number of individuals and species was recorded during the post monsoon season (Table 2).

Wolda (1988) concluded that there are differences in phenological pattern among the insect fauna typically in the temperate and tropical zones. However, it has been reported that the seasonal fluxuations are minimum in the tropics and hence the adults of the majority of species are present throughout the year (Owen, 1971), whereas in temperate zones adults are restricted to the most favourable seasons (usually spring and summer). Nevertheless, uniformity in phonological distribution pattern of butterfly species did not occur in the present study. In the present study it was observed that there were important differences in precipitation levels and to a lesser degree in temperature, which caused levels of evaporation to differ between seasons. The results indicate more number of species turnover (as represented by adults) from dry to rainy season.

Unique environmental attributes of each region should cause phenological patterns among the butterfly fauna to vary among them. Phenological studies on butterflies suggest that climate is the main factor controlling the activity of these organisms (Brakefield and Shreeve, 1992; Warren, 1992; Gutiérrez and Menéndez, 1998). However, climatic factors may be influenced by differences between habitats or years, correlated with microclimatic changes at local or regional levels. In this study, phenological similarities throughout the year were found with respect to trends in species richness Two periods of maximum species richness were distinguished: the period of greatest diversity during the rainy season, and the other peak during the post

Table 1. Diversity of Butterflies, family Papilionidae in Nilgiri hills

Sl. No.	Butterfly species	Common Name
	Papilionidae	Swallowtails
1	*Troides minos* Cramer	Southern Birdwing
2	*Pachliopta aristolochiae* Fab.	Common Rose
3	*Pachliopta hector* Linn.	Crimson Rose
4	*Graphium sarpedon* Linn.	Common Bluebottle
5	*Graphium agamemnon* Linn	Tailed Jay
6	*Graphium doson* C&R Felder	Common Jay
7	*Graphium nomius Esper*	Spot Sword tail
8	*Graphium antiphates* (Cramer)	Five Bar Swordtail
9	*Papilio demoleus* Linn.	Lime butterfly
10	*Papilio polytes* Linn.	Common Mormon
11	*Papilio polymnestor* Cramer	Blue Mormon
12	*Papilio Buddha* Westwood	Malabar Banded Peacock
13	*Papilio clytia* Linn.	Common Mime
14	*Papilio liomedon Moore*	Malabar Banded Swallowtail
15	*Papilio dravidarum* Wood Mason	Malabar Raven
16	*Papilio helenus Linn.*	Red Helen
17	*Papilio paris Linn.*	Paris Peacock
18	*Papilio crino Fab.*	Common Banded Peacock

Table 2. Abundance of butterflies, family Papilionidae in different seasons of Nilgiri hills

S.No.	Butterfly species	CommonName	No. of butterflies in different seasons				
	Papilionidae	Swallowtails		S	M	PM	W
1.	1	*Troides minos* Cramer	SouthernBirdwing	2	10	8	4
2.	2	*Pachliopta aristolochiae* Fab.	Common Rose	3	12	20	2
3.	3	*Pachliopta hector* Linn.	Crimson Rose	4	8	13	5
4.	4	*Graphium sarpedon* Linn.	Common Blue bottle	1	5	9	2
5.	5	*Graphium agamemnon* Linn.	Tailed Jay	8	10	15	6
6.	6	*Graphium doson* C&R Felder	Common Jay	17	10	1	6
7.	7	*Graphium nomius* Esper	Spot Sword tail	15	8	6	5
8.	8	*Graphium antiphates* (Cramer)	Five Bar Swordtail	8	17	15	10
9.	9	*Papilio demoleus* Linn.	Lime butterfly	6	15	20	7
10.	10	*Papilio polytes* Linn.	Common Mormon	7	11	15	4
11.	11	*Papilio polymnestor* Cramer	Blue Mormon	6	15	17	4
12.	12	*Papilio Buddha* Westwood	Malabar Banded Peacock	3	8	6	2
13.	13	*Papilio clytia* Linn.	Common Mime	5	15	10	7
14.	14	*Papilio liomedon*Moore	Malabar Banded Swallowtail	10	15	17	8
15.	15	*Papilio dravidarum* Wood Mason	Malabar Raven	15	14	10	8
16.	16	*Papilio helenus* Linn.	Red Helen	10	14	18	7
17.	17	*Papilio paris* Linn.	Paris Peacock	5	15	12	7
18.	18	*Papilio crino* Fab.	Common Banded Peacock	4	7	10	8

S: Summer, M: Monsoon, PM: Post Monsoon, W: Winter

Table 3. Habitat preference of butterflies, family Papilionidae in Niliri hills

S.No.	Butterfly species	CommonName	Habitat
	Papilionidae	Swallowtails	
1.	*Troides minos* Cramer	SouthernBirdwing	Lowland evergreen forest, mixed deciduous forest, try scurb and agricultural fields
2.	*Pachliopta aristolochiae* Fab.	Common Rose	Cultivated land, scrub, deciduous forest
3.	*Pachliopta hector* Linn.	Crimson Rose evergreen, evergreen forest	Dry deciduous forest, thick srub, semi
4.	*Graphium sarpedon* Linn.	Common Blue bottle	Ever green, semi evergreen, very common forest paths, stream sides, edges
5.	*Graphium Agamemnon* Linn.	Tailed Jay	Native evergreen and wet evergreen forest
6.	*Graphium doson* C&R Felder	Common Jay	Riparian, moist deciduous forest, semi evergreen and evergreen forest
7.	*Graphium nomius* Esper	Spot Sword tail	Deciduous and moist deciduous forest
8.	*Graphium antiphates (*Cramer)	Five Bar Swordtail	Evergreen and semi evergreen forest
9.	*Papilio demoleus* Linn.	Lime butterfly	Savannahs, fallow lands, gardens to semi evergreen and evergreen forest particularly stream and river bath
10.	*Papilio polytes* Linn.	Common Mormon	Deciduous forest, edges and opening in the semi evergreen and evergreen forests
11.	*Papilio polymnestor* Cramer	Blue Mormon	Riparian, moist deciduous forest
12.	*Papilio Buddha* Westwood	Malabar Banded Peacock evergreen forest	Lowland evergreen forest, semi
13.	*Papilio clytia* Linn.	Common Mime	Drydeciduous, moist deciduous, semi evergreen and riparian forests
14.	*Papilio liomedon*Moore	Malabar Banded	Evergreen and semi evergreen forest Swallowtail
15.	*Papilio dravidarum*	Malabar Raven	Evergreen and semi evergreen forest Wood Mason
16.	*Papilio helenus* Linn.	Red Helen	Evergreen and semi evergreen forest
17.	*Papilio paris* Linn.	Paris Peacock	Evergreen and semi evergreen forest
18.	*Papilio crino* Fab.	Common Banded Peacock	Dry deciduous,scrub and moist evergreen forest

Table 4. Larval host plants of butteflies, family Papilionidae in Nilgiri hills

S.No.	Butterfly species	CommonName	Larval host plants
	Papilionidae	Swallowtails	
1	*Trodies minos* Cramer	SouthernBirdwing	*Aristolochia indica,A. tagala, Thottea siliguosa*
2	*Pachliopta aristolochiae* Fab.	Common Rose	*Aristolochia indica, A. Bracteolate, A. Tagala, T. siliquosa*
3	*Pachliopta hector* Linn.	Crimson Rose	*Aristolochia indica, T.siliquosa*
4	*Graphium sarpedon* Linn.	Common Blue bottle	*Alseodaphne semicarpifolia, Cinnamomum camphora, C. Macrocarpum, C. Malabatrum, Litsea chinensis, Polyalthia longfolia*
5	*Graphium Agamemnon* Linn.	Tailed Jay	*Annona discolor, A. Muriaceta, A. Tericulata, A.squiamosa, Artabotrys hexapetalus, Cinnamomumspps, Michelia champsca, Miliusa tometosum, Polyalthia carasoides, P. longifolia*

6	*Graphium doson* C&R Felder	Common Jay	*Annona lawiii, Cinnamomum macrocarpum, Michelia, champaca, Miliusa tomentosum, Polyalthia longifolia*
7	*Graphium nomius* Esper	Spot Sword tail	*Miliusa tomentosum, M. venlutina and Polyalthia longifolia*
8	*Graphium antiphates* (Cramer)	Five Bar Swordtail	*Annona elegance, A. lawii, Miliusa sp and Uvria sp*
9	*Papilio demoleus* Linn.	Lime butterfly	*Aegle marmelos, Chloroxylon swietenia, Citrus aurantifolia, Citrus grandis, Citrus limon, Citrus sinensis, Glycosmis arborea, Murraya koenigii, Ruta graveolens*
10	*Papilio polytes* Linn.	Common Mormon	*Alantia racemosa, Aegle marmelos, Citrus aurantifolia, Citrus grandis, Citrus limon, Citrus medica, Glycosmis arborea, Murraya koenigii, M. Paniculata, Triphsia sp., Zanthoxylum rhetsa*
11	*Papilio polymnestor*	Blue Mormon	*Atalantia racemosa, Citrus grandis, Citrus limon, Glycosmis arborea, Paramigyna monophylla*
12	*Papilio Buddha* Westwood	Malabar Banded Peacock	*Zanthoxylum rhetsa*
13	*Papilio clytia* Linn.	Common Mime	*Alseodophae curpifolia, Cinnamomum comphora, C. macrocarpum, Litseachinensis L. deccanenis*
14	*Papilio liomedon*Moore	Malabar Banded Swallowtail	*Aeronychia pedunculata and Evodia roxbarghiam*
15	*Papilio dravidarum* Wood Mason	Malabar Raven	*Glysosmis arborea*
16	*Papilio helenus* Linn.	Red Helen	*Citrus sp., Clausena hepotophylla, Evodia sp., Glycosmis arborea, phellodendron sp., Toddalis asiatica, Zanthoxylum rhetsa*
17	*Papilio paris* Linn.	Paris Peacock	*Citrus sp., Evodia roxbrghisna, Toddalia asiatica, Zanthoxylum ovalifolium*
18	*Papilio crino* Fab.	Common Banded Peacock	*Chloroxylon swietenia*

Table 5. Adult nectar plants of butterflies, family Papilionidae in Nilgiri hills.

S.No.	Butterfly species	CommonName	Adult nectar plants
	Papilionidae	Swallowtails	
1	*Trodies minos*	SouthernBirdwing	*Lantana, Izora* and *mussaenda*
2	*Pachliopta aristolochiae*	Common Rose	*Lantana, Cosmos, Zinnia etc.*
3	*Pachliopta hector*	Crimson Rose	*Lantana*
4	*Graphium sarpedon*	Common Blue bottle	*Nectar from a variety of flowering herbs*
5	*Graphium Agamemnon*	Tailed Jay	*Lantana, Ixora, Mussaenda*
6	*Graphium doson*	Common Jay	*Leea, Cinnamomum*
7	*Graphium nomius*	Spot Sword tail	*Gmelina arborea,* Flowers of shrubs and large trees
8	*Graphium antiphates*	Five Bar Swordtail	*Unona lawii*
9	*Papilio demoleus*	Lime butterfly	*Lantana, Citrus plants*
10	*Papilio polytes*	Common Mormon	*Latana, Jatropha, Mussaenda, Txora, Asystasia, Peristrophe, Jasminum*
11	*Papilio polymnestor*	Blue Mormon	*Mussanenda, Frondosa Ixora coccinia fasminum*
12	*Papilio Buddha*	Malabar Banded Peacock	*Lantana and Clerodendrum paniculatum*

13	*Papilio clytia*	Common Mime	Flowers of shrubs and small trees
14	*Papilio liomedon*	Malabar Banded Swallowtail	*Lantana, citus*
15	*Papilio dravidarum*	Malabar Raven	*Chromolaena, lantana, Gliricidia, Gmelina arbora, Meyenia lariflora, Schleicheox aleosa*
16	*Papilio helenus*	Red Helen	*Lantana, Jatropha, Mussaend, Asystasia, Peristrophe, Jasminum*
17	*Papilio paris*	Paris Peacock	*Lantan*
18	*Papilio crino*	Common Banded Peacock	*Lantana*

monsoon season. This indicates that phonological patterns among tropical butterfly fauna are much more complex than it has been recognized.

The group of rare species may change from year to year due to seasonal and environmental variables, which have been poorly studied. Therefore, details on the specific mechanisms that lead to seasonal variation in the composition of rare species are needed to fully understand phenological patterns in any area. If we consider precipitation and temperature (causes of available humidity) as principal factors in determining the phenological patterns of vegetational communities, and therefore of butterflies, the timing and severity of the dry season is likely to be one of the most consequential factors in determining regional phenological patterns.

Papilionidae is composed of few species, most of which are large-bodied, often with small population sizes. Large butterflies are good at maintaining their water balance (Janzen and Schoener, 1968), the greatest problem confronted by insects during the dry season. The effect of humidity is important with respect to insect body size, and those organisms with small bodies desiccate more easily than those with medium to large bodies (Young, 1982). In addition, relatively consistent diversity of Papilionidae across the seasons could be related to phenological patterns of larval food plants or the availability of adult nectar or mineral resources (Gilbert and Singer, 1975).

The difference in diversity between wet and dry seasons was evident in all the forest areas (Table 3). Previous studies indicated that one of the main impacts of habitat modification such as selective logging is to reduce the spatial heterogeneity within forests (Hamer and Hill, 2000 ; Hamer *et al*., 2003), and the results of this study indicate a similar effect on temporal heterogeneity. Dry and wet season preferences of butterfliess showed distinct variation of the proportional abundance in both the seasons. These differences in butterfly abundances are due to well defined dry and wet seasons as well as distinct phenological state of plants in different seasons of the year (Table 4 and 5). But, this result contradicts with the findings of Wolda (1988), who stated that there was no distinct variation of dry and wet seasons that lead to less well-defined seasonal peaks. But the present study clearly reveals that the butterflies are highly seasonal in their distribution as in line with Hamer *et al*. (2003), who suggested that the highly dispersive opportunistic species are highly seasonal

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