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BUTTERFLY SPECIES RICHNESS AND SEASONALITY IN THE *ANACARDIUM* PLANTATION

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ABSTRACT
The composition, relative abundance and seasonal occurrence of butterflies in *Anacardium* plantation at visakhapatnam district was carried out during Aril 2008- March 2009. During the study period a total of 555 butterflies belonging to 22 genera with 29 species were encountered. Among the 29 species the most dominant species include *Junonia lemonias, Catopsilia pyranthe* and *Euthalia garuda*. The flowers of *Anacardium occidantale* were foraged for nectar by only six species *i.e., Castalius rosimon rosimon*, *Junonia iphita*, *Neptis hylas, Graphium agamemnon menides, Catopsilia pyranthe, Junonia lemonias*. About half of the total butterflies were encountered during monsoon season (July-October). *Euthalia garuda* was one of the abundant butterflies in the *Anacaridum* plantation, which is not so common in other habitat types. This may be due to the availability of mating locations and also because *Anacardium ocidantale* is one of the main larval host plants of *Euthalia garuda*.

INTRODUCTION

The occurrence of butterflies in a locality depends on the presence of plants since they are closely associated with plants both at adult and larval stages. Several of these butterflies are exclusive to certain habitats and their presence or absence serves to monitor ecological changes in the habitat. They accomplish pollination, an ecological process in natural sustainability of the plant species. Such beneficial insects suffered losses and declines in the past decades worldwide mainly due to habitat destruction. Agroforestry systems or plantation crops provide a habitat that is structurally more complex and often result in higher biodiversity (Estrada *et al.,* 1993, 1994; Armbrecht *et al.,* 2005). Such systems also play a crucial role in the conservation of biodiversity. Of late tropical forests are converted to tree plantations each year. Eucalyptus currently accounts for around 50% of all tree plantations (Evans and Turnbull, 2004). In Visakhapatnam district, plantations of *Anacardium*, Eucalyptus and *Casuarina* are replacing many crop fields. In view of the importance of the butterflies as pollinators of plants and indicators of habitat quality the present work on the species richness and seasonality of butterflies in an *Anacardium* plantation was carried out.

MATERIALS AND METHODS

The present study was carried during April 2008- March 2009 in a 10 hectare *Anacardium* plantation at Narapaka Village, Paravada mandal of Visakhapatnam (17º42'N; 83º20'E) district, Andhra Pradesh India. The climate of the area is tropical monsoon type and the normal total rainfall ranges between 1000-1500mL. The soils are very well drained sandy loam type and very much suitable for raising *Anacardium* plantations. Large tracts of land in this area are occupied by *Anacardium* Plantations and the plantation that is choosen in the present study is 10 years old and surrounded by trees of *Borasis flabellifer* as edge plant.

Field survey was done for the under story native vegetation by the transect-walk method (Pollard and Yates, 1993) in three seasons: Summer (April-June), Monsoon (July-October) and winter (November-March). In each season four samplings were made and at each time 18 line transects were considered. The plant species existing in the plantation were categorized into herbs, shrubs and trees. The terms used rare, common and abundant for recording the plant species are arbitrary and are suggestive of the relative estimates made in the field. Concurrently observations were made on the duration of the flowering of these plant species. Since *Anacardium* trees are recorded as larval hosts for *Euthalia garuda* the tree is observed for egg laying by this butterfly. Sampling of the butterflies was also made within 10 m on either side of the line transect and in each season four samples were taken. Transects were walked between 830 to 1500 h, which roughly corresponded to the peak activity period for most butterflies. The duration of sampling for each transect was between 30–45 minutes. Simultaneously the butterfly species feeding on the flowers were also recorded. Representative samples of butterflies were collected during field survey from the plantation using the methods described by De Rhe - Philipe (1931) and were identified by referring to Wynter-Blyth (1957), Larsen (1987, 1988), Gay *et al.,* (1992), Gunathilagaraj *et al.,* (1998) and Kunte (2000). For nomenclature Varshney (1980, 1985), Gunathilagaraj *et al.,* (1998) and Kunte (2000) were referred.

It has been verified for its validity from Zoological Survey of India, Kolkata.

RESULTS AND DISCUSSION

The composition, relative abundance and seasonal occurrence of butterfly populations are influenced by vegetation type, climate, habitat as well as incidence of parasites, predators and pathogens. The present study on the occurrence of the butterfly populations along with plant species serving as adult nectar host plants throughout the year (April, 2008 – March, 2009) in *Anacardium* plantation are described and discussed in detail.

Plant species, their prevalence and flowering periods

In the *Anacardium* plantation 52 plant taxa distributed among 26 families with 35 herbs, 8 shrubs and 9 trees were observed. Among the herbs *Justicia procumbens, Evolvulus alsinoides, Mimosa pudica*, and *Hybanthus ennaespermus* are abundant during monsoon and winter season. The majority of the other herbaceous taxa are also common during the above said period. Among the shrubs *Eupatorium odoratum, Ehretia microphylla, Cassia occidentalis,* and *Glycosmis pentaphylla* are common in their occurrence during the study period. Among the trees *Azadirachta indica* is the only taxon commonly found and the rest of the taxa are rare in their occurrence. Among the 52 taxa only 9 taxa are in flowering in all the three seasons of the year. The majority of the herbs are in flowering in monsoon and winter seasons while the trees bloom in summer (Fig. 1).

Composition, Relative abundance and Seasonality of the butterflies

During one year study period a total of 555 butterflies were sighted in a 10 hectare *Anacardium* plantation. Altogether 29 species belonging to 22 genera spread over 8 families were encountered. Among the 8 families Nymphalidae accommodated 8 species followed by Papilionidae (7), Lycaenidae, Danaidae, Satyridae, and Pieridae each with 3 species. The two remaining families Acraeidae and Hesperiidae are represented by only one species each. Of the eight different families Nymphalidae represented by 8 types contributed to a maximum of 35.49% followed by Pieridae (18.03%), Papilionidae (14.77%), Danaidae (10.45%), Lycaenidae (09.75%), Satyridae (05.58%), Acraeidae (04.14%) and Hesperiidae contributed the least (01.80%). While studying on butterfly communities in coffee plantations around a protected area in the Western Ghats, India Dolia *et al*. (2008) recorded 86 butterfly species belonging to five different families viz. Papilionidae, Pieridae, Nymphalidae, Lycaenidae, and Hesperiidae.

The yearly totals of 29 buttefly species, their order of dominance and their relative contribution are given in Table 1. Among the 29 species *Junonia lemonias* was the most dominant butterfly and contributed 11.35% to the total butterflies. The second dominant species was *Catopsilia pyranthe* with a contribution of 10.81%. The butterfly species that then followed in order were *Euthalia garuda,*(10.45%), *Euploea core* (09.01%), *Junonia iphita* (08.65%), *Eurema hecabe simulata* (05.04%), *Castalius rosimon rosimon* and *Zizeeria karsandra* (each 04.68%), *Acrea terpsicore* (04.14%) etc.

Butterflies may use *Anacardium* plantation and the other flora existing in it for different reasons *i.e.* use adult resources found in plantations, use adult as well as larval host plants and just pass through the plantations. Most food plants for butterflies are either understory shrubs or herbs (Kunte, 2000). Of the 29 butterfly species only six butterfly taxa *Castalius rosimon rosimon*, *Junonia iphita*, *Neptis hylas*, *Graphium agamemnon menides*, *Catopsilia pyranthe*, and *Junonia lemonias* forage on the nectar produced by the flowers of *Anacardium occidentale* (Table 2). Of these species *J. iphita* and *N. hylas* foraged exclusively only on the *Anacardium* flowers while the others foraged along with the other taxa. *Sida cordifolia* flowers are foraged by seven butterfly species, *Jasminum angustifolium* and *Eupatorium odoratum* are visited by five species each, and *Justicia procumbens* is visited by three butterfly species. Species that foraged on single plant taxa include *Acraea terpsicore* on *Eupatorium odoratum*, *Eurema hecabe simulata* and *Graphium doson* on *Sida cordifolia*, and *Princeps demoleus* on *Jasminum angustifolium*. *Euthalia garuda* fed mostly on fallen rotten fruits of *Borassus flabellifer*. *Elymnias caudata, Mycalesis visala subdita, Melanitis leda, Ariadne merione merione*, *Euthalia nais*, *Hypolimnas misippus, Junonia hierta*, *Rathinda amor*, *Papilio polymnestor*, *P. polytes polytes*, and *Borbo cinnara* did not forage either on the plant taxa existing in the plantation or on the overripe/rotten fruits present, thus they are the species which just passed through plantation.

Many studies correlated the butterfly species richness to the vegetation richness. Hawkins and Porter (2003) related butterfly species richness with vegetation richness at large but also found that such positive relationships may only be correlative, with both groups responding similar environmental factors. The link between vegetation richness and butterfly richness at local scales has stronger support: Gilbert and Smiley (1978) found a positive relationship between the number of species of heliconid butterflies and their *Passiflora* host plants, and Steffan-Dewenter and Tscharntke (2000) reported a close correlation between butterfly and vegetation richness in European grasslands. Poyry *et al.,* (2009) indicated that the local habitat quality is of foremost importance in explaining variation in species richness and total density of butterflies and moths. Furthermore, host- plant specificity is a key correlate of extinction risk in butterflies (Koh, 2007) and the presence or absence of a small number of specific host plants could have a large influence on butterfly diversity. However these relationships are not ubiquitous and Schulze *et al.,* (2004) and Veddeler *et al.* (2005) failed to find a relationship between understorey richness and the richness of fruit feeding butterfly in a study of land-use change in Indonesia, and Singer and Ehrlich (1991) found no evidence of a relationship between the richness of forest Satyrinae and their monocotyledonous host plants in Trinidad. Fitzherbert *et al.* (2006) found low abundance and species richness of butterflies in cultivated habitats but high in open riverine habitats, and many butterfly species were found only in seasonally flooded grassland. Dolia *et al.* (2008) analysed the abundance and species richness of butterflies in coffee plantations around a protected area. The Bhadra wildlife sanctuary and found

higher abundance and richness with the transects close to the protected area than transects further away. Most forest dependent species such as *Kallima horsfieldii*, *Tanaecia liepidea*, *Zipoetis saitis*, *Parthenos sylvia*, *Papilio paris*, *P. buddha*, and *Graphium nomius* in coffee plantations close to the PA. Barlow *et al.* (2008) while working the diversity and composition of fruit feeding butterflies in *Eucalyptus* plantations captured a total of 2,200 butterflies and 56 species at the 30 sampled *Eucalyptus* plantation sites. *Hamadryas feronia* was the only species present at all the sites and the second most abundant species also. The analysis of the 13 most abundant species revealed a fairly consistent influence of vegetation richness on species from with in the Satyrinae, for *Yphthimoides renata* had a stronger effect by the percentage ground cover than vegetation richness and non of the variables had significant effects on *Magneuptychia libye*.

The seasonal overall butterfly population trend was represented in Fig. 2. During the study period about half (46.84%) of the total butterflies sighted were recovered during monsoon season (July-October). The onset of rains results in an enormous increase in the number of species that have occurred at low frequency throughout the dry season. The monsoon rains triggered the growth and subsequent flowering of herbaceous taxa. The presence of majority of the abundant and common herbaceous species in flowering during monsoon might have attracted the butterflies as a source of nectar. The abundant and common herbaceous species flowering during monsoon include *Alternanthera sessilis*, *Euphorbia hirta, Evolvulus alsinoides*, *Hybanthes enneaspermus*, *Justicia procumbens*, and *Vernonia cinerea*. The remaining half of the butterflies sighted is shared almost equally between summer (April-June) - 27.03% and winter (November-March) - 26.13%. In summer herbaceous species such as *Alternanthera sessilis*, *Hybanthes enneaspermus, Vernonia cinerea*, and the tree *Azadirachta indica* were in flowering and served as adult nectar host plants. During winter herbaceous species such as *Alternanthera sessilis*, *Evolvulus alsinoides Hybanthes enneaspermus, Vernonia cinerea* and the shrub *Eupatorium odoratum* are in flowering and contributed nectar to the adults. The major contributors to monsoon abundance are the members of Nymphalidae, Papilionidae, and Pieridae. The families which contributed more or less equally to the three seasons include Satyridae, Acraeidae and Lycaenidae. The members of Danaidae appeared only during winter season and the members of Hesperiidae are absent in summer.

Among the eight families, the members of Nymphalidae outnumbered the others in all the three seasons (Fig. 3) followed by Pieridae, Papilionidae, Danaidae, Lycaenidae, Satyridae, Acraeidae, and Hesperiidae. The same order of abundance is also found in summer (Fig. 4) and monsoon (Fig. 5). The observations of Dolia *et al.* (2008) are somewhat coincided with our results on *Anacardium* plantations that in both the studies Nymphalidae were the dominant members contributing to the community structure. However the second dominant family in the present study was Pieridae and at coffee plantations it was Lycaenidae. At *Anacardium* plantations the members of Hesperiidae are absent in summer. In winter (Fig. 6) season members of Nymphalidae are followed by Pieridae. The next dominant members belong to Danaidae and Lycaenidae with equal sightings. These families are followed by Papilionidae. Satyridae and Acraeidae with equal sightings contributed equally in this season and Hesperiidae is the least contributor.

With respect to the seasonal trends of individual butterfly species, all the dominant species like *J. lemonias, C. pyranthe, E. garuda, E. c. core, J. iphita, E. h. simulata* are found in the three seasons of the year. *J. lemonias* and *J. iphita* are more abundant during monsoon season and distributed equally in winter and summer seasons. *C. pyranthe* and *E. garuda* are also abundant during monsoon followed by summer and winter seasons. *E. c. core* and *A. terpsicore* are sighted equally in all the three seasons. *E. h. simulata* is more dominant during winter and the other two seasons witnessed equally. *C. r. rosimon* was equally abundant in monsoon and winter seasons while *Z. karsandra* is more in numbers during summer and winter seasons. The other species which are found in all the seasons but in less numbers include *Elymnias caudata, Ariadne merione merione, Neptis hylas, Pachliopta aristolochiae aristolochiae, P. hector* and *Papilio polytes polytes*. Some species like *Mycalesis visala subdita*, *Euthalia nais, Hypolimnas misippus, Junonia hierta, Rathinda amor, Graphium doson,* and *Princeps demoleus* are sighted only during monsoon season. *Danaus chrysippus chrysippus*, *Tirumala limniace* and *Papilio polymnestor* are witnessed only during winter. *Borbo cinnera* is absent in summer, *Melanitis leda ismene* in monsoon, *G. agamemnon menides* and *Leptosia nina* in winter. Similar kind of seasonal trends in the butterfly occurrence in tropical and temperate environments were observed. Owen *et al.* (1972) observed Acraeidae members to occur in all months of the year but with a tendency to reach peak abundance at a particular time of the year. In temperate regions the forest species are common in the wet season and savanna species more common in the dry season. Kunte (1997) showed that species richness was highest in late monsoon and early winter. Majority of the butterfly species also showed abundance peaks in these seasons. Nayak *et al.* (2004) observed that there was a fluctuation in number of butterfly species in various seasons at different sites. In Nasik, Kumta, Mala, Dhoni there were more number of species in pre-monsoon season than monsoon and post-monsoon. Emmel and Leck (1970) found considerable fluctuation in population size from month to month for most species of butterflies. These changes were usually associated with the change from wet season to dry season. However many species reached their population peaks during the transition period between wet and dry seasons.

Many of the life history studies indicated that the larvae of the butterflies feed mostly on herb and shrub flora. The larval host of *Leptosia nina* is *Capparis spinosa* (Samatha *et al.,* 2008), *Pachliopta aristolochiae* are *Aristlochia bracteolata* and *A. indica* (Atluri *et al.,* 2001, 2004a), *Anaphaeis aurota* are *Capparis spinosa, C. zeylanica* (Venkata Ramana *et al.,* 2003), *Acraea terpsicore* is *Hybanthus ennaespermus* (Atluri *et al.,* 1999), *Danaus chrysippus* are *Calotropis procera* and *Asclepias currasavica, Pergularia daemia* (Vekata Ramana *et al.,* 1998). Some of the herb and shrub flora in the Anacardium plantation might have served as larval host plants of the butterflies encountered in the present study. Very few

Table 1: Prevalence order of butterflies and their percentage contribution to the total butterflies in *Anacardium* plantations at Narapaka village

Butterfly species	Yearly total	% contribution
Junonia lemonias	63	11.35
Catopsilia pyranthe	60	10.81
Euthalia garuda	58	10.45
Euploea core core	50	09.01
Junonia iphita	48	08.65
Eurema hecabe simulata	28	05.04
Castalius rosimon rosimon	26	04.68
Zizeeria kasandra	26	04.68
Acraea terpsicore	23	04.14
Pachliopta hector	17	03.06
Papilio polytes polytes	17	03.06
Elymnias caudata	16	02.88
Graphium agamemnon menides	16	02.88
Pachliopta aristolochiae aristolochiae	16	02.88
Leptosia nina	12	02.16
Melanitis leda ismene	11	01.98
Junonia hierta	10	01.80
Princeps demoleus	10	01.80
Borbo cinnara	10	01.80
Neptis hylas	07	01.26
Danaus chrysippus chrysippus	05	00.90
Ariadne merione merione	05	00.90
Mycalesis visala subdita	04	00.72
Euthalia nais	04	00.72
Graphium doson	04	00.72
Danaus limniace leopardus	03	00.54
Hypolimnas misippus	02	00.36
Rathinda amor	02	00.36
Papilio polymnestor	02	00.36

observations showed that the butterfly larvae feed on tree species. *Elymnias caudata* feeds on *Areca catechu* (Samatha 2006), *Graphium agamemnon menides* and *G. doson* both on *Polyalthia longifolia* (Atluri *et al.,* 2002a), *Papilio polytes* on *Murraya koenigii* and *Citrus* Spp. (Vekata Ramana *et al.,* 1996), *Princeps demoleus* on *Citrus* Spp. (Atluri *et al.,* 2002b)

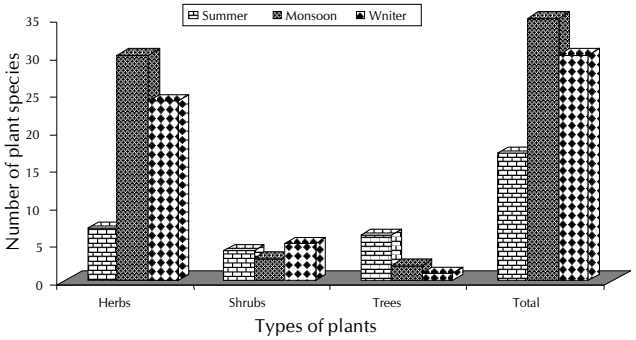

Figure 1: Number of plant species in flowering during different seasons of the study period

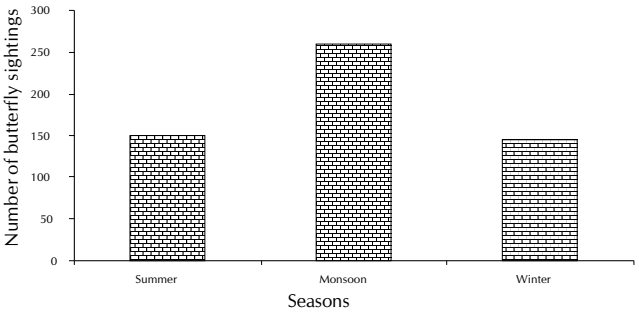

Figure 2: Overall population trends of butterflies during different seasons of the study period

and *Catopsilia pyranthe* on *Cassia* Spp. (Atluri *et al.,* 2004b). Tree plantations have the potential to provide a conservation service in much of the humid tropics since they are rapidly increasing in extent and present less of a structural contrast with native vegetation than many more intensive agricultural land uses (Barlow *et al.,* 2008).

Euthalia garuda, which is not so common in other habitat types, was recorded as one of the abundant butterflies in *Anacardium* plantation of present study. This may be not only

Table 2. Nectar resources of butterflies occurring in *Anacardium* plantations

S.No.	Name of the butterfly species	Adult nectar resources
1.	*Acrea terpsicore*	*Eupatorium odoratum*
2.	*Danaus chrysippus*	*Azadirachta indica, Eupatorium odoratum, Euphorbia hirta, Jasminum angustifolium* and,*Moringa oleifera*.
3.	*Tirumala limniace*	*Anacrdium occidentale* and *Eupatorium odoratum*.
4.	*Euploea core*	*Anacrdium occidentale, Eupatorium odoratum,* and *Carissa carandas*.
5.	*Castalius rosimon rosimon*	*Alternanthera sessilis*, *Anacardium occidentale*, *Justicia procumbens,* and *Sida* sps.
6.	*Zizeeria karsandra*	*Justicia procumbens, Tephrosia purpurea,* and *Vernonia cinerea*.
7.	*Euthalia garuda*	Feeds on fallen and rotten fruits of *Borassus flabellifer*.
8.	*Junonia lemonias*	*Anacardium occidentale, Eupatorium odoratum,* and *Ocimum sanctum*.
9.	*Junonia iphita*	*Anacardium occidentale*
10.	*Neptis hylas*	*Anacardium occidentale*
11.	*Graphium agamemnon menides*	*Sida cordifolia* and *Anacardium occidentale*
12.	*Graphium doson*	*Sida cordifolia*
13.	*Pachliopta aristolochiae aristolochiae*	*Sida acuta, Sida cordifolia*, and *Jasminum angustifolium*.
14.	*Pachliopta hector*	*Carissa carandas, Jasminum angustifolium*, *Sida acuta* and *Sida cordifolia*.
15.	*Princeps demoleus*	*Jasminum angustifolium*
16.	*Catopsilia pyranthe*	*Jasminum angustifolium*, *Sida cordifolia* and *Anacardium occidentale*.
17.	*Eurema hecabe simulata*	*Sida cordifolia*
18.	*Leptosia nina*	*Vernonia cinerea*, *Evolvulus alsinoides, Hybanthes enneaspermus, Justicia procumbens, Sida acuta,* and *Sida veronicaefolia*.

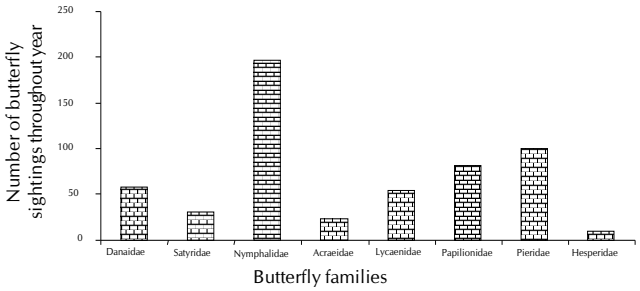

Figure 3: Population trends of different families during the study period

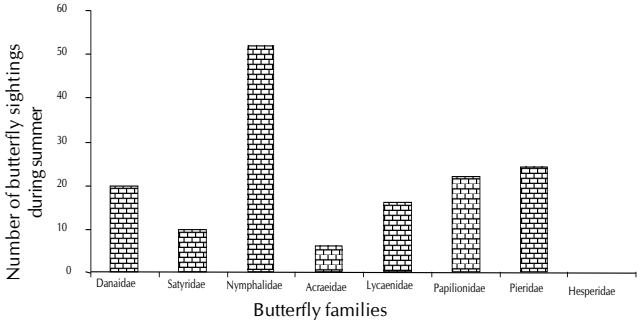

Figure 4: Population trends of different families during summer

due to the availability of understorey bushes that served as mating locations but also because *Anacardium occidentale* is one of the main larval host plants of *Euthalia garuda*. The female butterfly lays eggs singly on the upper surface of fresh leaves, usually above 5 m above the ground level. The fallen rotten fruits from *Borassus flabellifer* that were planted along the edge of the plantations serve as adult food resources. Hence, in view of the availability of mating locations, adult and larval resources in the same habitat, *Anacardium* plantations of the present study area may be regarded as best conservation sites for this fruit feeding tropical butterfly, *Euthalia garuda*.

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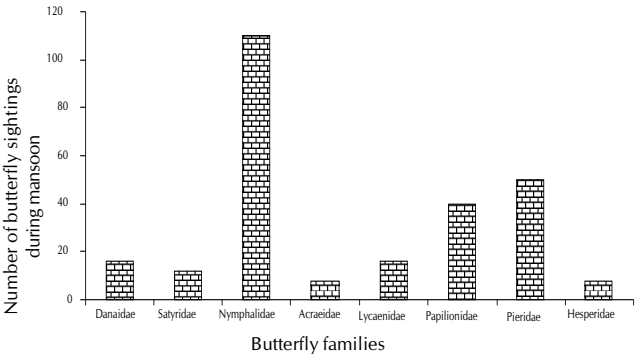

Figure 5: Population trends of different families during monsoon

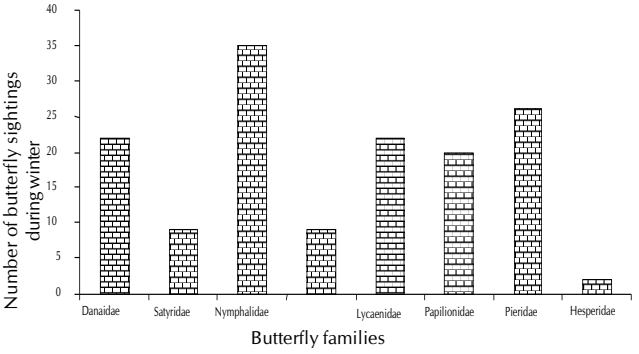

Figure 6: Population trends of different families during winter

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