Recent Research in Science and Technology 2012, 4(11):28-33
ISSN: 2076-5061
Available Online: http://recent-science.com/

What determines the abundance of butterflies? - A short search

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Abstract
Butterflies neither seem to be identical nor abundant throughout the year. Their numbers decline over a period of time owing to harsh climatic changes or anthropological activities. Their appearance in the same place fluctuates with seasonal changes. With a view to this, abundance of some selected butterflies near the University campus in relation to the environmental factors like light, variations in temperature, humidity and rainfall was evaluated. Of the four species selected, *Eurema hecabe and Catopsilia pomona (Lepidoptera: Pieridae*) exhibited abundance throughout the study period while *Ixias marianne* (Lepidoptera: Pieridae) and *Danaus chrysippus* (Lepidoptera: Nymphalidae) were less abundant. Abundance was maximum during the post monsoon months, August and September. There was a positive correlation for *I. marianne* with minimum temperature, relative humidity and rainfall ($p<0.05$) while a negative correlation was observed with mean maximum temperature ($p<0.05$) at both places. This was also true for *C. pomona* from BG for mean relative humidity at evening ($p<0.05$). However, there is not much variation in the abundance pattern from both the places.

Keywords: *Eurema hecabe, Catopsilia pomona, Ixias marianne, Danaus chrysippus*

INTRODUCTION

Insects are ideal for monitoring various landscapes for biological conservation. Among them butterflies are especially useful for ecological evaluation (Thomas and Malorie,1985; Kim,1993; Samways,1994; Pollard and Yates,1993; New *et al*., 1995; Simonson *et al.,* 2001). Abiotic factors like variations in temperature, humidity and solar radiations have profound influence on the activity of any insect at any given time. This is especially true for small ectotherms such as butterflies because of their reduced thermal inertia (Rutowski, 1984; Piexoto and Benson, 2009).

As per the records of Kunte (1997), India possesses 1501 butterfly species with a majority of them in the North-eastern region. They provide good opportunities for studies on population and community ecology (Pollard,1991) as they are very sensitive to change in microclimate and habitat (Evehardt,1985; Kreman,1992). Lepidopterans have important ecosystem roles as they form an important part of food web and act as good pollinators and bio-indicators (Chakravarty *et al.,* 1997; Jana et al. 2009) in addition to enhancing the aesthetic value of our environment (Alluri *et al*., 2004). Seasonality is not a strange phenomenon in insect population (Kunte, 1997; Hussain *et al*., 2011). Their population dynamics are generally influenced by environmental factors like temperature, rainfall, humidity, photoperiod, variations in the availability of food resources and vegetation cover for the larval and adult stage (Anu *et al*., 2009; Tiple *et al*., 2009; Rajagopal *et al*., 2011). There is an increasing interest in conserving and managing butterflies as their diversity and density is diminishing very rapidly with increased pollution, reduced water quality, habitat degradation, urbanization and decreased plant species diversity (Singh *et al.,* 2009; Rajagopal *et al*., 2011). With a view to this we have initiated this study from the campus.

There are many areas in our University campus which have provided good locations for the field studies including identification of different species of insects and understanding the influence of environmental factors for their abundance or decline. However, the Campus which was a good abode to many insect species, is now facing a decline in their density and diversity due to many natural and anthropogenic factors. Hence in the present study, two most frequently monitored areas were selected with a specific interest on some butterfly species. They were near Lower bridge (LB) area behind the department of Geology and (2) Botanical garden (BG) near the department of Botany (Figure 1). The first area is a natural one with natural vegetation and a rivulet flowing through it. The vegetations include different species of *Cassia, Calotropis, Datura, Capparis, Caesalpinia, Crotolaria, Lantana* etc., while the second area is a protected garden with vegetations of *Hylanthus, Terminalic, Randia, Sependes, Carrisa, Tetrocarpus, Capparis* etc. Our previous studies have shown a wide diversity of insects from these places which include many species of the orders of Odonata, Lepidoptera, Diptera, Orthoptera, Coleoptera and Hymenoptera. After initial observations for a period of one month, in the present study, four butterfly species were selected, as two of them were very common and two of them were very rare in these places, to see the environmental effect on their abundance. The selected species were *Eurema hecabe (Linnaeus 1758)* (Common grass yellow), *Ixias marianne* (Cramer 1779) (White orange tip), *Catopsilia pomona* (Fabricius 1775) (Common emigrant) (Lepidoptera: Pieridae) and *Danaus chrysippus (Linnaeus 1758)* (Plain tiger) (Lepidoptera: Nymphalidae). Despite its limitations, the study did attempt to monitor short term butterfly diversity in the campus.

Received: May 05, 2012; Revised: Oct 17, 2012; Accepted: Nov 24, 2012.
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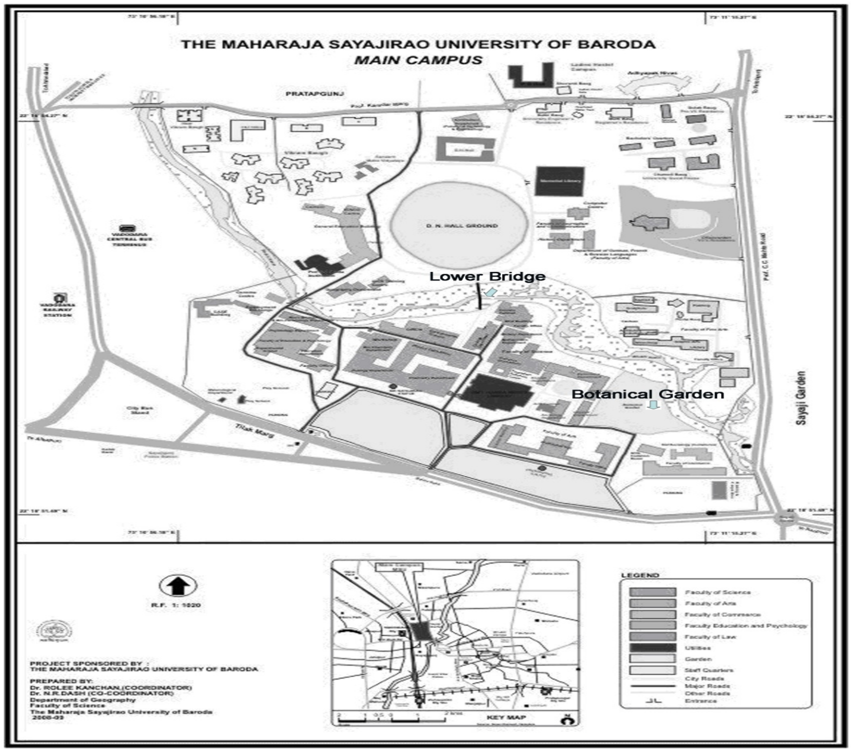


Fig 1. Map of MSU campus showing the location of study areas LB and BG

MATERIALS AND METHODS

The abundance and foraging nature of the selected butterflies and the interference of climatic factors on their abundance was ascertained on alternate days from LB and BG for a period of six months. In the month of June 2008, both the areas were observed in the morning and afternoon and a record was made of the diverse butterfly species along with other insects. Great care was taken as to not kill any insects. Majority of them were identified in the field itself while some species were collected and identified and released to the same spot within a short time. Some of them were identified after taking photographs. These measures were done with a view to preserve the species diversity and density of the area. From July to December, observations were made at 06:00 a.m., 09:00 a.m., 12:00 p.m., 03:00 p.m., 06:00 p.m. and beyond 06:00 p.m. so as to ascertain the occurrence of these butterfly species at different time periods of the same day. A 15-30 min visual survey was done at all heights and distances in the area during each sampling period and the occurrence and abundance of these butterflies were recorded individually. At the end of one month their total and mean values were calculated so as to obtain a monthly data. Other relevant details such as availability of the larval food plants and readings of meteorological parameters like minimum and maximum temperature, relative humidity, and rainfall were recorded from the Meteorological department of the University. The mean values per month of these data were calculated and statistically subjected to correlation analysis with different species of butterflies using appropriate formula (Frank and Althoens, 1994).

RESULTS

A total of 12 species comprising three families and ten genera of Lepidoptera were recorded during the study. Pieridae (58%) was dominant in terms of species abundance followed by Papilionidae (33%) (Table 1). In general, the occurrence of butterflies were comparatively more at LB area than that of BG (Figures 2a and b).

Table 1. List of butterflies observed at LB and BG area

Sr. No.	Common name	Scientific name	Family
1	Tailed Jay	*Graphium agamemnon Linnaeus,1758*	Papilionidae
2	Common crow	*Euploea core Cramer,1780*	Nymphalidae
3	Danaid eggfly	*Hypolimnus misippus, Linnaeus,1764*	Nymphalidae
4	Plain tiger	*Danaus chryssipus Linnaeus,1758*	Nymphalidae
5	Great eggfly	*Hypolimnus bolina Linnaeus,1758*	Nymphalidae
6	Common jezebel	*Delias eucharis Drury,1773*	Pieridae
7	Pioneer	*Anaphaeis aurota Fabricius,1793*	Pieridae
8	Common emigrant	*Catopsilia pomona Fabricius,1775*	Pieridae
9	Yellow orange tip	*Ixias pyrene Linnaeus,1764*	Pieridae
10	White orange tip	*Ixias marianne Cramer,1779*	Pieridae
11	Common grass yellow	*Eurema hecabe Linnaeus,1758*	Pieridae
12	Crimson tip	*Colotis danae Fabricius,1775*	Pieridae

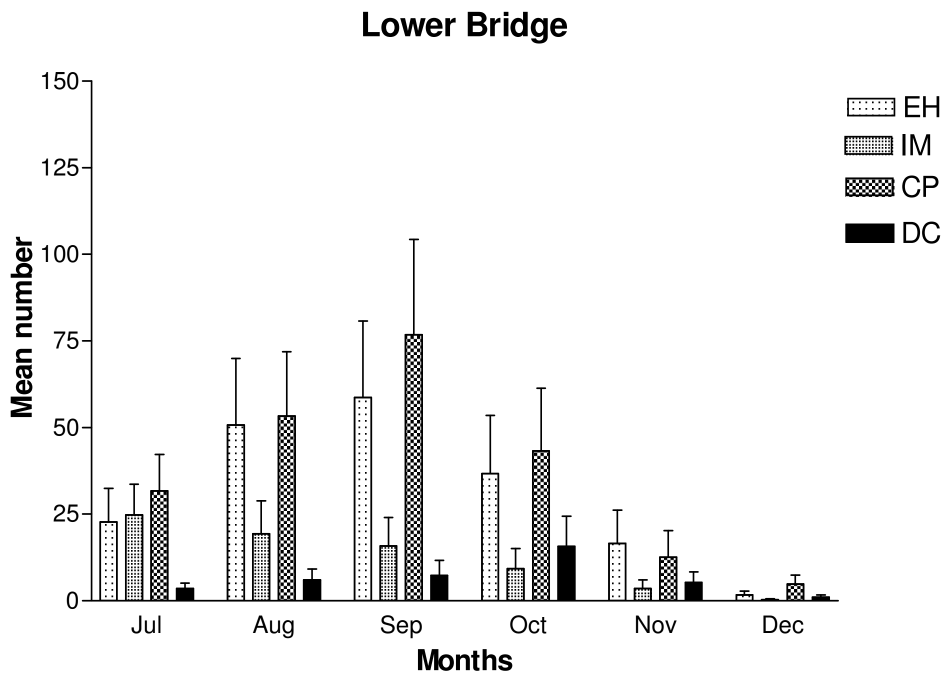


Fig 2a. Mean number of butterflies observed during different months from LB area

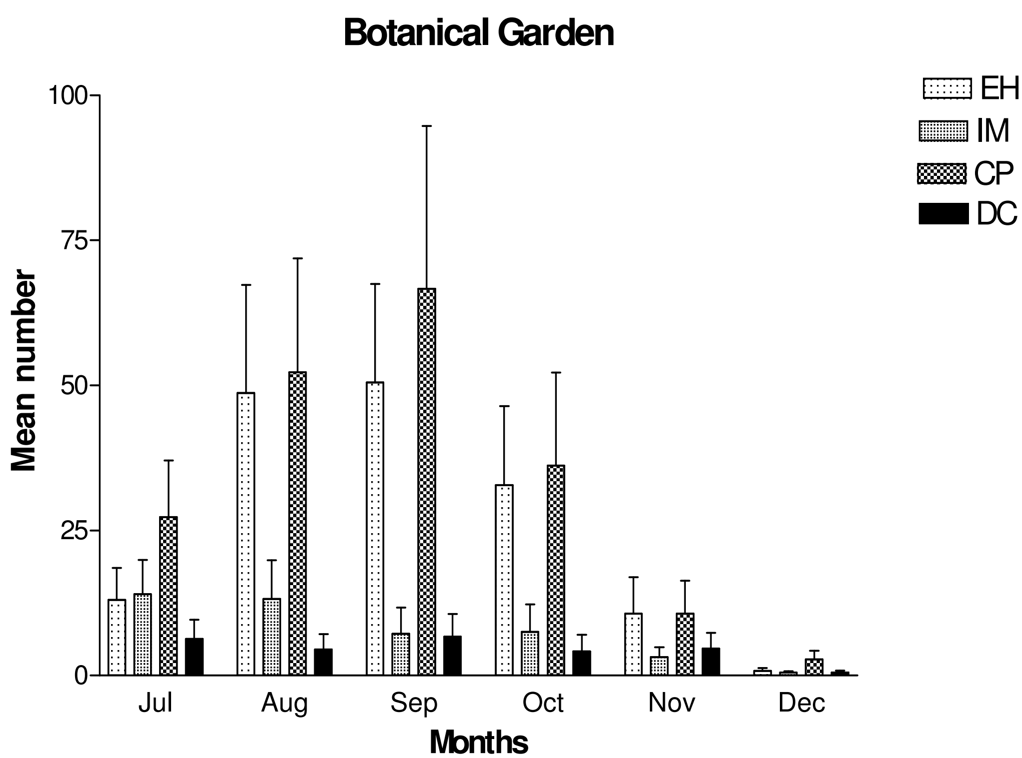
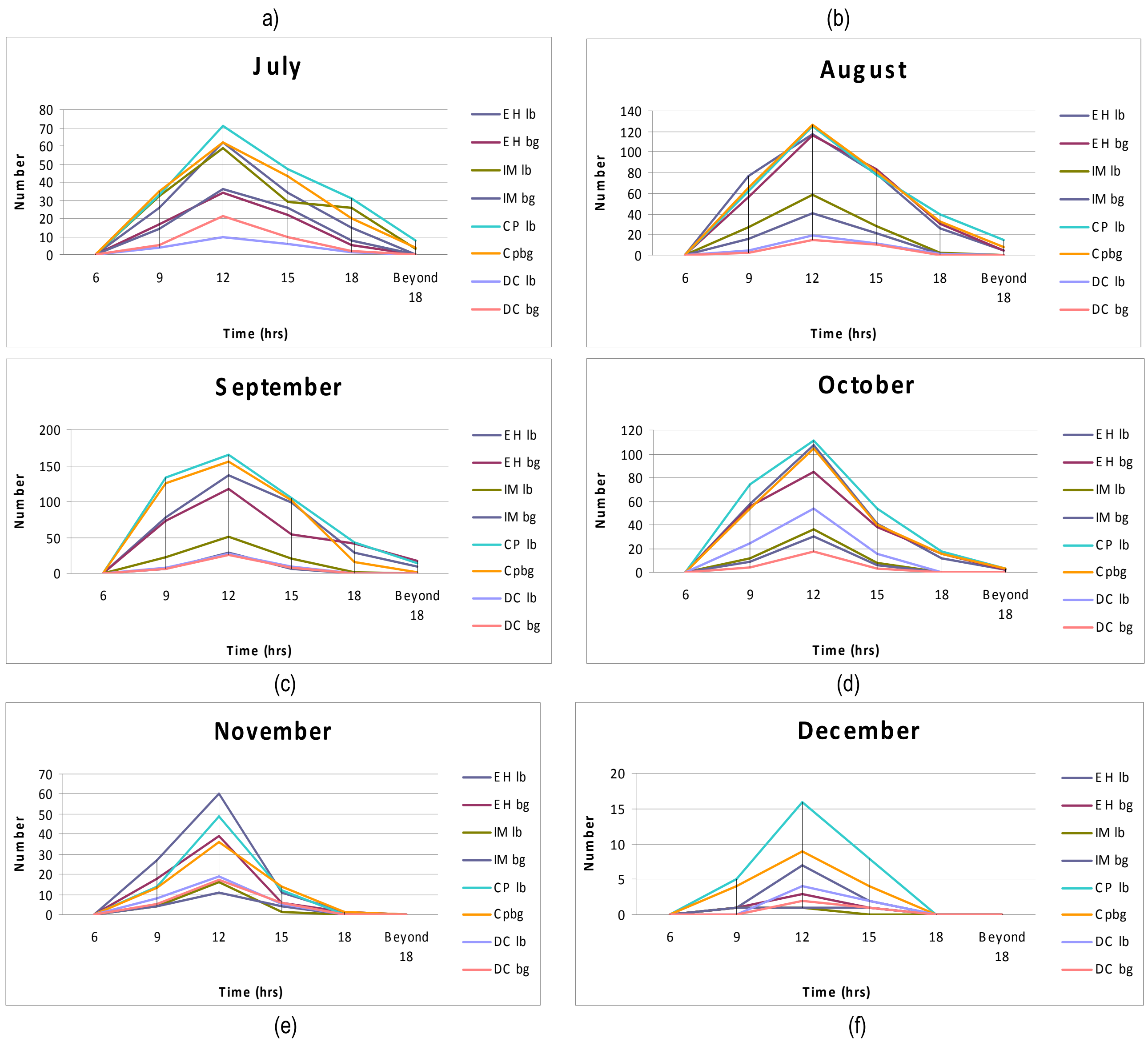


Fig 2b. Mean number of butterflies observed during different months from BG area

Figures 3a-f depict the number of butterflies observed at different time periods during different months. No butterfly species was observed at 6:00 a.m. in the morning while they started appearing slowly and increased in number during later periods. The maximum abundance was observed at 12:00 p.m. and showed a decline further in all months studied. However, August and September were found to be ideal as maximum number of butterflies were observed during these months (Figures 2-3). Of the four selected butterflies *C. pomona* and *E. hecabe* showed abundance at any time point from both the places except for the month of July, when *I. marianne* exceeded *E. hecabe* (Figures2-3). Maximum abundance of *E. hecabe* was observed during the months of August and September (Figures 2-3) whereas *C. pomona* which was the highest recorded at any time point, was maximum during September (Figures 2-3)



Figs 3(a-f). Mean number of butterflies observed at different time periods from LB and BG area for the months of July to December.

Comparatively *I. marianne* and *D. chrysippus* were less abundant. *I. marianne* was abundant during the months of July and August while *D. chrysippus* was comparatively more during October from LB but showed more or less stable pattern from BG with little increase during the months of July and September (Figures 2-3). At any observation point in the day, they were less from both the places.

The correlation analysis between weather parameters and butterfly abundance at LB and BG are given in Table 2. During the present study abundance was associated with monsoon season and thus the abundance and fluctuations were positively correlated with minimum temperature, relative humidity and rainfall ($p<0.05$) while a negative correlation was observed for *I. marianne* with mean maximum temperature ($p<0.05$) at both places. This was also true for *C. pomona* from BG for mean relative humidity at evening ($p<0.05$). No butterflies were observed during rainfall but immediately after the rainfall when the sun shined, they made their appearance.

Table 2. Correlation coefficient (r) between butterfly species and weather parameters at MSU campus, Vadodara, Gujarat.

WEATHER PARAMETERS	LOWER BRIDGE (A)				BOTANICAL GARDEN (B)			
	E. hecabe	*D. Chryssipus*	*I. Marianne*	*C. pomona*	*E. hecabe*	*D. Chryssipus*	*I. marianne*	*C. pomona*
X_1	0.7078	0.1470	0.8458*	0.7507	0.5774	0.7846	0.8585*	0.6889
X_2	0.5774	0.7192	-0.6147	0.1242	0.6650	0.4066	-0.3386	0.0955
X_3	0.6568	0.0296	0.9456*	0.6089	0.5533	0.2413	0.9506*	0.6923
X_4	0.6162	0.3827	0.9404*	0.6042	0.5306	0.6186	0.8507*	-0.0732
X_5	0.2742	0.1127	0.9058*	0.2685	0.1784	0.4111	0.9229*	0.2792

Where,
X_1= mean minimum temperatue (ºC), X_2= mean maximum temperature (ºC), X_3= mean RH at morning, X_4= mean RH at evening, X_5= mean Rainfall (MMS)
* Significant at p<.0.05 level

DISCUSSION

Daily variations in temperature, solar radiation, wind and humidity are reported to influence when an insect should be active and what it should be doing at any given point of time (Piexoto and Benson, 2009). In particular, daily variations of temperature and light strongly influence the habitat selection and activity patterns due to their surface area to mass ratio (May, 1979). Therefore period of high air temperature and solar heating turn out to be potentially lethal while low temperatures result in inefficient breeding activities (Srygley and Kingslover, 2000; Brewaerts and Van Dyck, 2004; Rane *et al*., 2004).

Occurrence and abundance of Lepidopterans is influenced by many of these environmental factors. Light acts as a token stimulus for them which indicates whether the season is favorable or not. In some cases stimulus may be provided by a gradient in light intensity. The diurnal rhythm in intensity of light and quality of light is associated with rhythm in temperature, moisture, food etc. (Awasthi, 1997) and any change in light intensity may lead them to a place where there is surplus food. In other cases stimulus can be provided by length of the day, which serves as a clock informing them of the seasonal changes in temperature, moisture, food etc., Moreover in India, many reports show that monsoon govern the distribution of butterfly diversity to a large extent and they flourish post monsoon (Didham and Springate, 2003; Hill *et al.,* 2001; Kunte, 2005; Padhye *et al*., 2006; Tiple and Khurad, 2009).

Out of the two places selected for the present study, LB area favored more number of butterflies than the BG as expected due to its natural vegetation and availability of more food plants as reported by other researchers from different places of India (Kunte, 1997; Tiple *et al*., 2009., Hussain *et al*., 2011). However, at both places *E. hecabe* and *C. pomona* were found to be abundant throughout the study period as compared to *I.* m*arianne* and *D. chryssipus*. Of the two pioneer species, *C. pomona* outnumbered *E. hecabe* at most of the time periods.

The relationship between butterflies and climate are complex involving all four stages of the life cycle and their food habit which indirectly govern their abundance (Hussain *et al*., 2011). Many reports show that availability of food plant and larval host plants play a major role in diversity and abundance pattern (Southwood,1975). Foraging nature is mostly determined by the availability of food resources. In both places, abundance was noted after the rainy season when there was an increase in vegetation and floral density. Optimum light, temperature and rainfall usually increase the vegetation and thereby directly favor their abundance. Butterflies are abundant when the flower density is high as they could maximize the net rate of energy intake per unit time as suggested by Choudhary *et al*. ,(2002). Hence a direct correlation was observed for the abundance of these butterflies with floral density and intensity of light and larval host plant (Gilbert and Singer, 1975; Southwood, 1975; Kitahara *et al*., 2000; Kunte, 2000-01; Hussain *et al*., 2011). All the four species increased in number from July, flourished and maximized during the months of August, September and October and declined considerably during November and December. The increase is directly correlated with the increase in vegetation and larval host plants in the area after the rainy season. The decline during November and December was owed to a decrease in food availability, photoperiod and temperature due to the approach of winter season.

Many of the butterflies undergo diapause when the temperature is too low or too high (Awasthi, 1997). Photoperiod is one of the significant factor since changes in day length are effective predictors of future seasonal environmental conditions. Photoperiod increases as the summer heat approaches and diminishes towards the winter cold. Moreover, the absence of any butterfly species at 6.00 am in the morning and 6.00 pm in the evening and a high occurrence at midday is definitely an indication to the fact that increased light intensity plays an important role for their appearance.

Mathew and Anto (2007) have reported that temperature ranges between 27-29^{o}C and humidity ranging between 60-89 % are the most favorable for butterfly growth at Peechi, Kerala. Hussain *et al*., (2011) have shown that the period between September to February was conducive for butterfly communities mainly due to optimum temperature and high humidity at Kalpakkam, Tamilnadu. However in the present study the optimum temperature was found between 26-35^{o}C and humidity between 62-83 %. This naturally can be correlated with the regional differences. Other studies also show that temperature and precipitation are two vital factors which influence butterfly richness and population directly (Kunte 2000-01; Padhye *et al*., 2006; Tiple and Khurad , 2009).

In the present study significant correlation was observed for *I. Marianne,* whose abundance was influenced by most of the abiotic factors taken into consideration. *E. hecabe* and *C.* p*omona* were favourably influenced by all the factors and they were more abundant during the months of August and September. *D. chrysippus* was found to be the least abundant throughout the study period and were not significantly affected by the variations. The study gains significance as the conservation of different species requires close monitoring of the correlation with the patterns of the environmental cycles.

ACKNOWLEDGEMENTS

Ruchi Naik would like to thank Head, Department of Zoology, for providing necessary facilities to carry out the studies and Dr D. K. Patel, Department of Statistics, for helping in statistical analysis. Thanks are due to Dr. Rolee Kanchan and Dr. N. R. Dash of Dept. of Geography for providing the MSU map.

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