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Diversity and Abundance of Butterfly Fauna at the Kaudulla National Park

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Abstract: **The objective of the study was to record the diversity and abundance of butterflies in the Kaudulla National Park (KNP) during the rainy (January to April) and the dry season (June to September). Two sites viz. the entrance area and along the roadside were selected. A linear transect was used for sampling and all the sighted butterflies were identified. The census was carried out from 7.00 am to 5.00 pm. Shannon index (H') was used to compare the diversity within sites. The student t-test was used to test the significance of the variation in the number of individuals present between sites. Twenty three species were recorded representing four families viz. Nymphalidae, Papilionidae, Lycaenidae and Pieridae. The number of species recorded in both sites were similar while the habitat along the roadside recorded higher number of individuals and diversity in both wet (H'= 2.301) and dry (H'= 1.7323) periods compared to the wet (H'=1.300) and dry (H'=0.673) periods in entrance area. However, there is no significant difference in the number of individuals between sites. Two peak visitations were recorded in the morning and the afternoon. The census indicates a gradual increase in species diversity and abundance from January to April, followed by a decline in May. A gradual decrease in rainfall and increase in temperature followed a sudden increase in wind speed may have led to the disappearance of the annual green vegetation in May and this could be attributed for low abundance of butterflies in May.**

Keywords: **Abundance, Butterfly, Diversity, Kaudulla National Park, Seasonality, Visitation.**

1. INTRODUCTION

Insects comprise the majority of earth's diversity of animal species and among insects, butterflies are the best-known group to have a favorable image with general public. According to Schreiner and Nafus (1997) this is due to their great aesthetic value owing to bright colors, interesting behaviors and daytime activity periods making them easy for everyone to enjoy. Hence they are an excellent group for communicating information on science and conservation among general public (Robbins and Opler, 1997). Recent studies of biodiversity in relation to ecosystem functioning have suggested that species diversity sometimes enhance productivity and stability of ecosystems (Naeem et al., 1994: Tilman et al., 1996). Butterflies and their larvae play an important roles in ecosystem functioning, including nutrient cycling and pollination (Janzen, 1987; Schowalter, 2006).

Food of butterflies play an important role in determining their distribution, abundance and movement (Kunte, 2000) while the availability of larval food plants is of prime importance for having a breeding population in a given habitat (Vane-Wright, 1978) which mainly consist with secondary growths consisting of shrubs, herbs, creepers and saplings (Nimbalkar et al., 2010). Human activities have introduced monocultures and also some exotic plant species which compete with native plants, making a threat to larval food plants (Kamini and Jolanta 2007). Most adult butterflies found in temperate regions feed on nectar, while fruit-feeding butterflies are found mainly in tropical and subtropical regions and feed on rotting fruits, exuded tree sap, mud carrion, and dung (Boggs and Jackson 1991; Omura et al., 2000; DeVries and Walla 2001; Krenn 2008).

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In addition to biotic factors, abiotic factors also influence the diversity of butterflies. Particularly, abiotic constraints are especially important to small ectotherms like butterflies owing to their reduced thermal inertia (Rutowski et al., 1994). Butterfly activity depends on the daily variation of solar radiation, air temperature, wind speed and humidity (Douwes 1976 and Ribeiro and Freitas, 2010). Tropical butterflies have been shown to be sensitive to seasonal changes in rainfall (Hill et al., 2003). Daily variations of high solar radiation and air temperatures may be potentially lethal (van der Have 2002). Particularly, according to Rutowski et al., (1994) and Ide (2002b), heat, even when not permanently debilitating, may aggravate desiccation and compromise adaptive behavior.

Landscape features viz the size of the patch, its heterogeneity and connectivity also can be major controllers of species composition and abundance, and thus population viability, for sensitive species such as butterflies (Noss and Harris 1986). As described by Murphy and Weiss (1988), for the determination of butterfly populations the consistency in environmental conditions is vital. Butterflies are one of the best studied groups of insects and they are highly sensitive to habitat or climatic changes (UKBMS 2006). They plays an important role in ecosystems and their occurrence and diversity are considered as good indicators of health of the terrestrial biota (Kunte, 2000; Koh and Sodhi 2004) and offer a number of logistical advantages over other potential indicative taxa such as unlike other insect groups, many butterfly species can be easily identified in the field using field guides (Basset et al., 2011).

In Sri Lanka, 245 species of butterflies have been recorded of which 26 species are endemic (van der Poorten, 2012). Out of the recorded species, 99 species (including 22 endemics) are considered as threatened of which 21 species (including 5 endemics) are critically endangered, 38 species (including 10 endemics) are endangered and 40 species (including 7 endemics) are vulnerable (van der Poorten, 2012). According to van der Poorten (2012), in Sri Lanka, the distribution of butterfly fauna is determined by the climate, topography and the geology of the particular area and many butterfly species are generalists and occur in a range of climatic zones while few species display a restricted distribution. Although there has been a great deal of emphasis on the conservation of mammals and birds, the lack of effort to conserve butterflies in Sri Lanka is primarily a reflection of the lack of information on the current status of butterflies in the island. Therefore, it is important to record the species present in different parts of the country (van der poorten and van der poorten 2008). Hence, the present study was undertaken to assess the extent to which Kaudulla National Park (KNP) may contribute to the conservation of the country's butterfly species.

2. MATERIALS AND METHODS

2.1 Study area:

The field study of butterflies was conducted in the KNP located north of the main road connecting Habarana and Polonnaruwa in the North Central province of Sri Lanka, between latitudes 6" 47' N and longitudes 80" 46' and 80" 50' E in the catchment of the Kaudulla Reservoir. The extent of the KNP is 6690 ha. It is a new park, opened to visitation only in 2002. The average annual rainfall of KNP is between 1500 mm to 2000 mm while the average annual temperature ranges between 20 ^{0}C to 35^{0}C. It receives rain from the north-east monsoon. The park experiences two marked seasons, wet and dry. The wet period persists from January to April and the dry period persists from June to September (DWC, 2005). In addition to trees and shrubs, many herbaceous and grass species grow well during the wet season. However, during dry season only perennial shrubs and trees are prominent.

2.2 Site selection:

The butterfly survey was carried out in two distinct habitats in two different locations *viz*, at the entrance area of the KNP and along the road side from the upper edge of Kaudulla Tank to Gal Oya junction. The entrance area mainly consists of grasses and trees while the road side vegetation mainly consists with secondary vegetation which includes shrubs and herbaceous plants.

2.3 Data collection and analysis:

A linear transect of 250 m long and 3 m wide was set up in each place and marked in the field and landmarked for repeated observations. The transect in each place was slowly traversed according to standard 'Pollard Walk' methodology (1975) at a uniform pace for 20 minutes per hour weekly from 7.00 a.m. to 5.00 p.m. on sunny days during the rainy season (from January to April) and during the dry season (from June to September). All butterfly species in flight or at

rest on plants were recorded using a field data sheet. To avoid counting the same individual more than once observation and tracking of individual butterflies was required. Care was taken to avoid redundant tally of butterflies that kept moving down the track in the same direction as the walk. When an exact identification of the species was not possible, an insect sweep net was used to capture the butterflies in question to facilitate field identification. For the species that could not be identified on the spot, photographs were taken with a digital camera and later identified in the laboratory using the available literature (Banks and Banks, 1985; D'abrera, 1998 and Woodhouse 1952). The national conservation status was determined by the National Red list (MOE, 2012).

The Shannon-Wiener diversity index (1949) was used to compare the diversity of butterfly species within sites.

Shannon-Wiener diversity index = H' = – ∑ Pi In Pi

Where Pi = S/N

S = number of individuals of one species.

N = total number of all individuals in the sample

In = logarithm to base e

The student t-test was used to test the significance of the variation in the number of butterfly species present between sites. Temperature, rainfall and wind speed data in the KNP during the study period was obtained from the Meteorological department at Polonnaruwa.

3. RESULT

3.1 Butterfly diversity and abundance:

Twenty three different species of butterflies were identified at the entrance and along the road side of KNP (Table 1) and all the recorded species were present at both sites. Butterflies belonged to four families *viz*. Nymphalidae, Papilionidae, Pieridae and Lycaenidae and each were represented by 12, 6, 3 and 2 species respectively. Out of the species recorded, three species namely Ceylon rose (*Pachliopta jophon*), Ceylon tree nymph (*Idea iasonia*) and Jewel four ring (*Ypthima singala*) are endangered while Ceylon tree nymph and Blue glassy tiger (*Ideopsis similis*) were listed under the vulnerable category during the National Red listing 2012.

Table 1: Butterflies present at the entrance and along the road side of KNP.

Zoological name	Common name	Family	National Red List Category 2012
*Graphium sarpedon**	Common bluebottle	Papilionidae	LC
Papilio polytes	Common Mormon	Papilionidae	LC
Papilio demoleus	Lime butterfly	Papilionidae	LC
*Pachliopta aristolochiae**	Common rose	Papilionidae	LC
*Troides darsius**	Sri Lanka Birdwing	Papilionidae	LC
*Pachliopta jophon**	Sri Lankan Rose	Papilionidae	EN
Ypthima ceylonica	White-four-rings	Nymphalidae	LC
Orsotriaena medus	Nigger (Medus Brown)	Nymphalidae	LC
Neptis hylas	Common sailer	Nymphalidae	LC
Acraea violae	Tawny coster	Nymphalidae	LC
Junonia iphita	Chocolate Pansy/Soldier	Nymphalidae	LC
*Junonia lemonias**	Lemon pancy	Nymphalidae	LC
Ideopsis similis	Blue glassy tiger	Nymphalidae	VU
*Euploea core**	Common Indian crow	Nymphalidae	LC
*Mycalesis subdita**	Sri Lankan Tamil Bushbrown	Nymphalidae	LC
Hypolimnas misippus	Danaid eggfly	Nymphalidae	LC
*Ypthima singala**	Sri Lankan Jewel four-rings	Nymphalidae	EN
*Idea iasonia**	Sri Lanka Tree Nymph	Nymphalidae	VU/EN
Catochrysops strabo	Forget-me-not	Lycaenidae	LC
Zizina Otis	Lesser grass blue	Lycaenidae	LC
*Belenoise aurota**	Pioneer	Pieridae	LC
Eurema hecabe	Common grass yellow	Pieridae	LC
Prioneris sita	Painted sawtooth	Pieridae	LC

*LC – Least Concerned, EN – Endangered, VU – Vulnerable, * Endemic*

The habitat along the roadside recorded a higher number of individuals compared to the entrance area (Figure 1). The family-wise distribution of butterflies showed that members of Nymphalidae dominated in the both sites (3790 individuals along the roadside and 3007 in the entrance area) followed by Lycaenidae, Papilionidae and Pieridae.

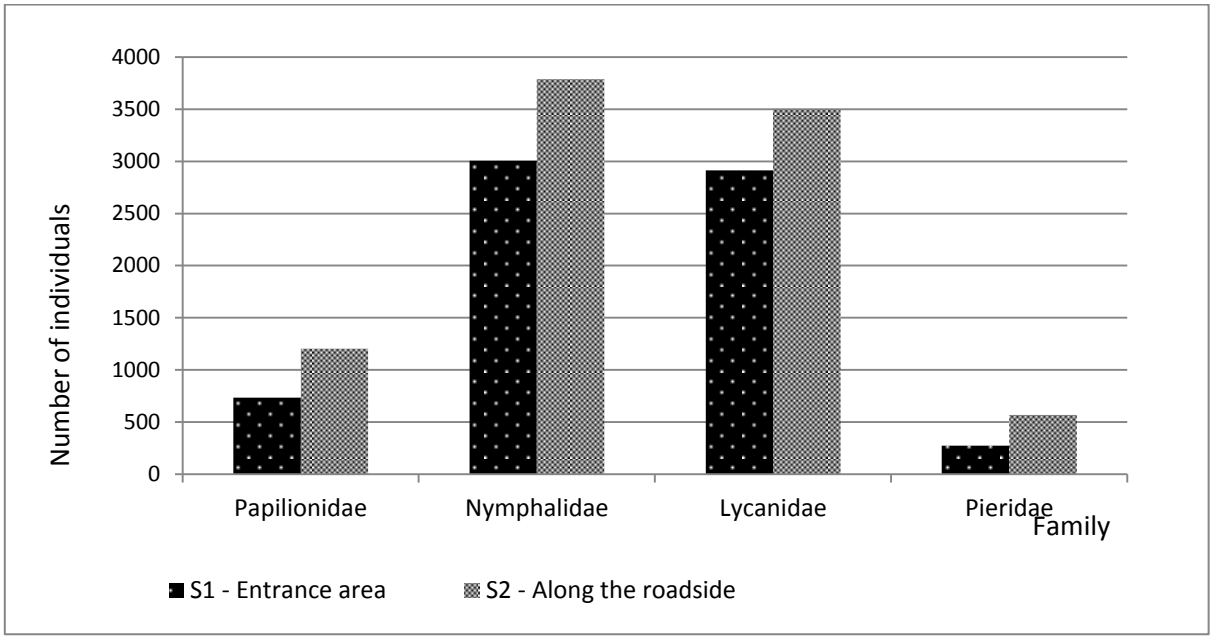

Figure 1: Butterflies present at the entrance and along the roadside of KNP

3.2 Seasonal variation in abundance:

The census indicates a gradual increase in species abundance from January to April in both sites with a peak in April, followed by a sharp decline in May (Figure 2). At the peak 609 individuals were recorded along the roadside while 534 individuals were recorded in the entrance area (Figure 2). During the dry season from June to September, a sudden falling off of numbers was recorded from June to July and this was followed by a gradual decrease in species abundance. During the study period, in both sites at any given time species abundance was high in the wet season compared to the dry season.

According to the student t-test, in both wet and dry seasons, there was no significant difference between the means of the two sites. However, the number of butterflies recorded along the roadside was greater than in the entrance area.

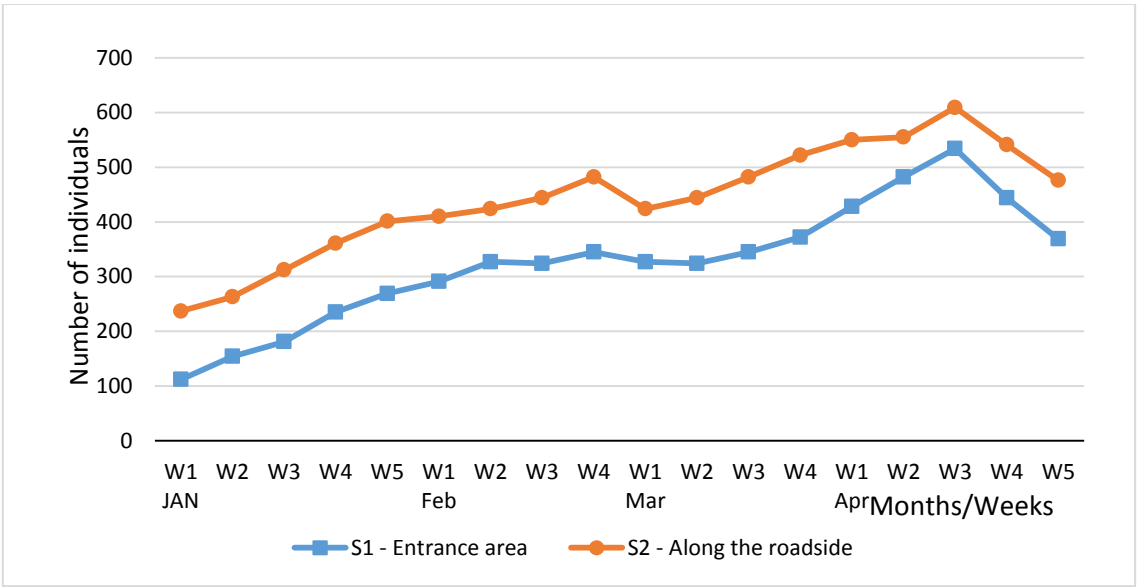

Figure 2 – Visitation pattern of butterflies from January to April on 2013 at KNP.

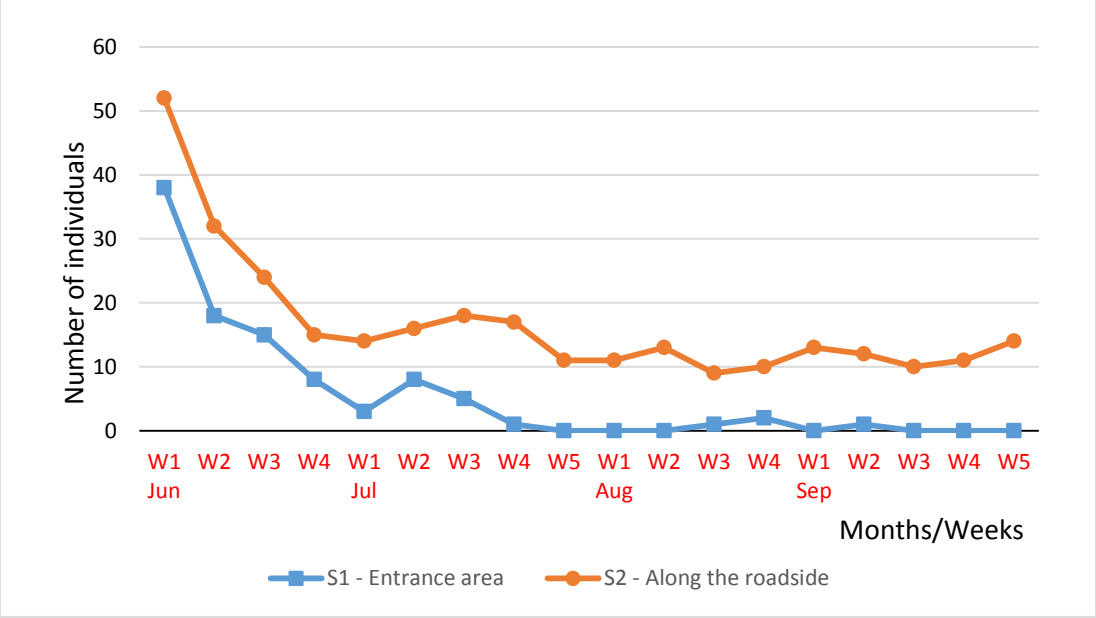

Figure 3 – Visitation pattern of butterflies from June to September on 2013 at KNP.

Shannon – wiener diversity index (H') of visitation pattern of butterflies in wet and dry seasons for the two different sites is given in Figure 4. In both wet and dry seasons, the number of species recorded along the roadside was greater (H'= 2.301and H'= 1.7323 respectively) than in the entrance area (H'=1.300 and H'=0.673 respectively).

The lesser grass blue (*Zizina otis*) (41.06 %) and white four rings (*Ypthima ceylonica*) (25.18 %) were the most abundant species in both sites while the Ceylon tree nymph (*Idea iasonia*) (0.017 %) and Sri Lanka bird wing (*Troides darsius*) (0.026 %) were the rarest.

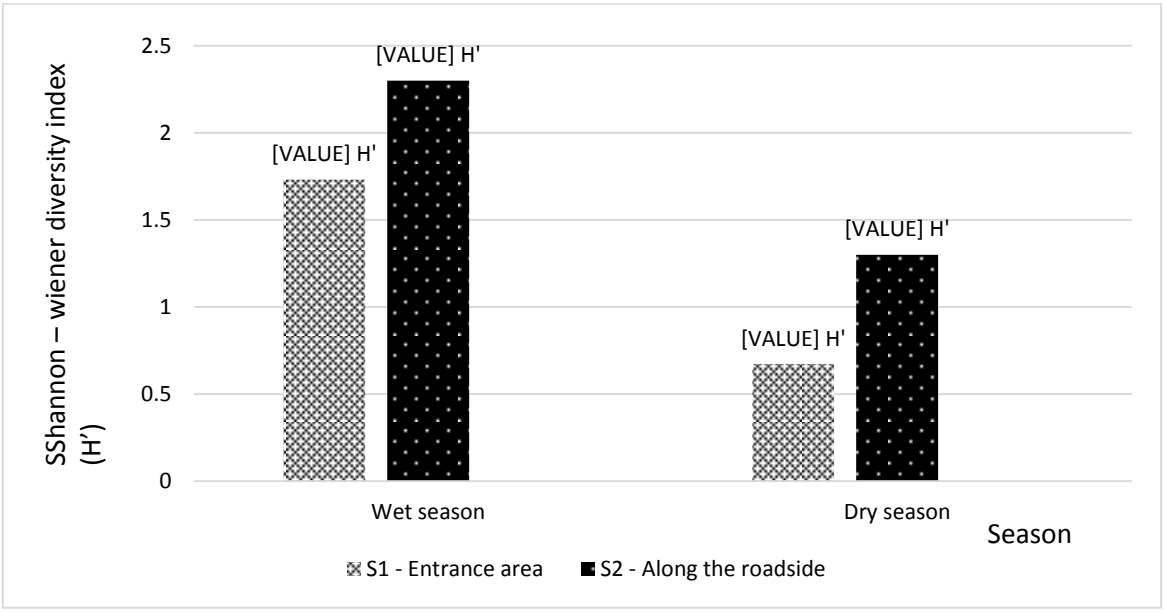

Figure 4 – Shannon – wiener diversity index (H') of visitation pattern of butterflies in wet and dry seasons on 2013 at KNP

In KNP, a gradual decrease in rainfall was recorded from January to May and this was followed by a dry period from June to September. This was followed by a gradual increase in rainfall from October (Figure 5). The temperature gradually increased from January to April and it was gradually decreased from October. While more or less constant wind speed was recorded from January to April, a sudden increase in wind speed was recorded in May until September and this gradually decreased again.

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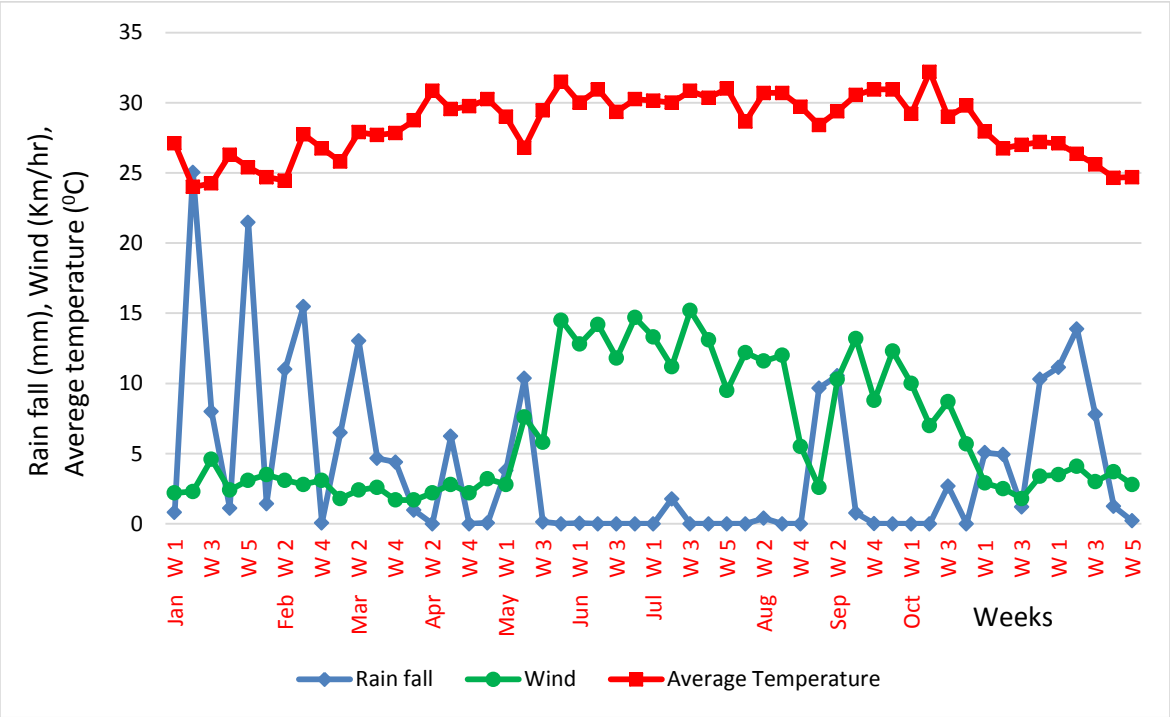

Figure 5: Rain fall, Wind and Average temperature patterns from January to December on 2013 at KNP.

3.3 Daily visitation pattern:

The daily distribution pattern of butterflies during the day time at KNP is given in Figure 6. A gradual increase in visitation was recorded from 7.00 am until 10. 00 am and a peak was recorded from 10.00 am to 10.30 am. This was followed by a gradual decline. Another peak was recorded from and 3.00 pm to 3.30 pm followed by a shape decline.

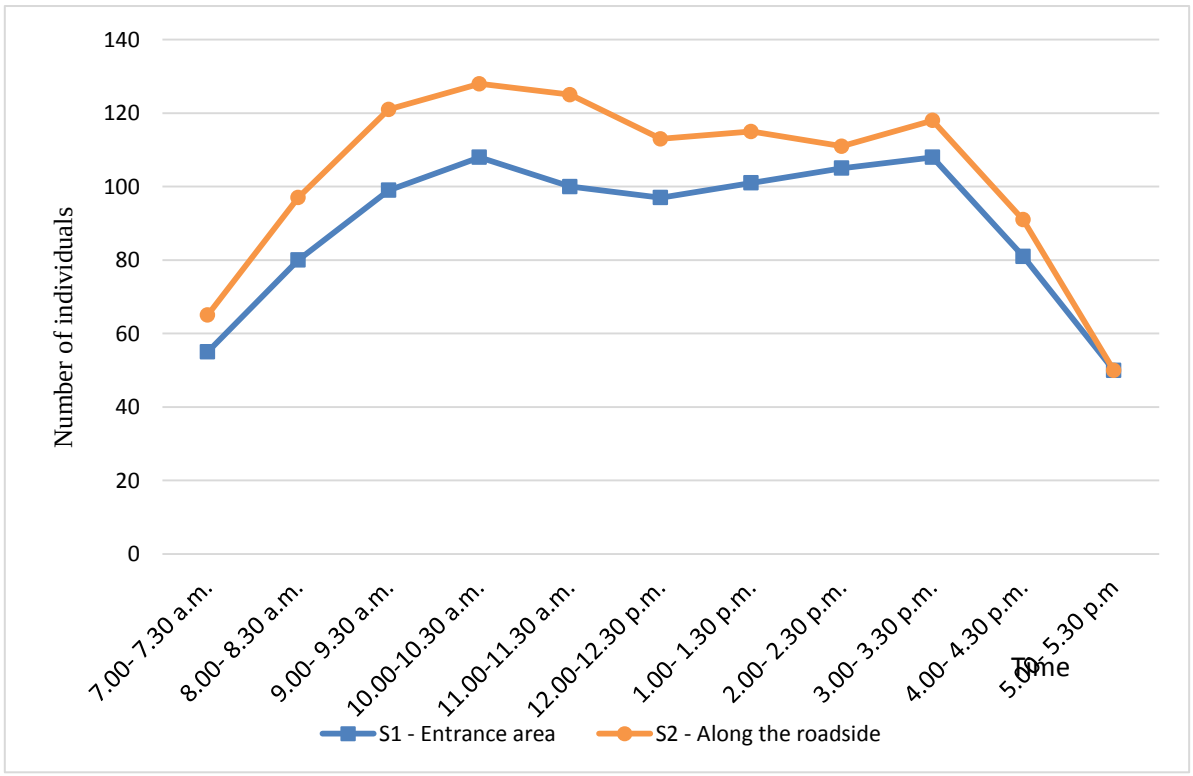

Figure 6: Distribution pattern of butterflies during the day time at KNP.

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4. DISCUSSION

A total number of 23 species belonging to 4 families in the order Lepidoptera were recorded in the KNP which represent 9.3 % of the butterfly fauna present in the country. According to Leps and Spitzer (1990), a positive relationship have been found between butterfly diversity and plant diversity and this relationship is particularly true in tropical regions, where insects show high abundance and species diversity (Price 1997). In the KNP, butterfly species richness is high in both sites though there was no significant difference between the means of the two sites. Both sites were represented by herbs, shrubs and grasses. Butterfly diversity indirectly reflects an overall diversity of plants, especially herbs and shrubs in a given area (Jha *et al*., 2000).

In areas with no distinct wet and dry season, the abundance and activity of butterflies are less variable (Hebert 1980, Wolda & Galindo 1981) However, in the tropical regions with distinct wet and dry seasons, butterflies attain maximum adult abundance during the wet season, probably in response to changes in plant physiology and growth (Didham and Springate 2003, Wolda 1989), in particular the abundance of new foliage (Fensham 1994, Novotny and Basset 1998). According to Hill *et al*., (2003), tropical butterflies have been shown to be sensitive to seasonal changes in rainfall. In the KNP distinct wet and dry periods were observed and accordingly, the abundance of butterfly species also varied. A gradual decrease in rainfall and gradual increase in temperature was recorded from January to May and a sudden increase in wind speed was observed in May in KNP (Figure 5). This led to the disappearance of the annual green vegetation from late April to August. In particular, herbs start their life cycle in the beginning of the wet season and complete with the onset of the dry season in the late April. Accordingly, after a peak in the 3rd week of April, a decreasing trend was recorded for butterfly abundance (Figure 2). Low rainfall, high temperatures and high wind speeds were recorded from May to September and the disappearance of green vegetation was witnessed during this period. Accordingly, abundance of butterflies was low during this period (Figure 3). Gutierrez & Mendez (1995) suggested that the abundance of butterflies is not affected by altitudes but it is more related to the availability of food plants.

Butterflies have many ways to regulate body temperature and avoid stressful conditions during the day by altering posture or changing micro habitat (Clench 1966; Rutowski *et al*., 1994; Ide 2002a). In particular, daily variations of solar radiation and air temperature may strongly influence the activity pattern and the types of habitat used by small species due to their great surface/mas ratio (May 1979). Accordingly, butterfly abundance was increased from 7.00 am until 10.00 am. After the peak from 10.00 – 10.30 am a gradual decrease in abundance was witnessed corresponding to the increase in temperature towards noon.

5. CONCLUSION

The census results 23 different species of butterflies belonging to four families. Though the butterfly species recorded in two different habitat types was the same, the habitat along the roadside a recorded higher number of individuals and diversity in both wet (H'= 2.301) and dry (H'= 1.7323) periods compared to the wet (H'=1.300) and dry (H'=0.673) periods in the entrance area. However, according to the student t-test, there is no significant difference in the number of individual butterfly species between sites. Two peaks from 10.00 am to 10.30 am and from and 3.00 pm to 3.30 pm were recorded in the daily distribution pattern of butterflies. The census indicates a gradual increase in both species diversity and abundance from January to April with a peak in April, followed by a sharp decline in May which corresponds to the gradual decrease in rainfall and gradual increase in temperature in KNP from January to May with a sudden increase in wind speed in May. This led to the disappearance of the annual green vegetation in May and this could be attributed for a sudden decrease of butterfly abundance in May.

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