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Comparison of butterfly diversity in natural and regenerating forest in a biodiversity conservation site at maragamuwa, Sri Lanka

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Abstract

Knowledge of species composition and diversity of butterflies offers great benefits for nature conservation and environmental monitoring. Butterfly species richness and diversity were studied at a biodiversity conservation site at Maragamuwa, Sri Lanka from July 2009 to February 2010 using the fixed distance line transect method. A total of 4968 butterflies belonging to the super families Papilionoidea and Hesperioidea, representing six families and 83 species were recorded during the study period. Of these 83 species, 73 were recorded from the natural forest, while 60 species were recorded from the regenerating forest. The highest numerical abundance of butterflies was recorded from the regenerating forest and the highest species diversity occurred in the natural forest. These observations suggest that the short term monitoring of butterfly assemblages provide monitoring tool for the habitat conservation.

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Introduction

Biodiversity monitoring can be facilitated by selecting one or few groups of animals, instead of all, due to the limitations of time, money and human resources. Butterflies are numerous in Sri Lanka and they become particularly abundant during migratory flight periods (D'Abrera, 1998). A total of 245 butterfly species have been recorded from Sri Lanka to date, of which 23 are endemic to the island, while 66 are listed as nationally threatened by IUCN (2007). Six families of butterflies are represented in Sri Lanka, namely: Hesperiidae, Lycaenidae, Nymphalidae, Riodinidae, Papilionidae and Pieridae. Numerous studies have suggested that butterflies are well suited for studying habitat use and for biodiversity monitoring since their community parameters reflect land use pattern changes (Hill *et al.*, 2011; Koh, 2007; Kunte, 1997, 2000; Kunte *et al.*, 1999; Summerville & Crist, 2001; Waltert *et al.*, 2011). Also, previous studies have suggested that butterflies can be used as ecological indicators (Brown & Freitas, 2000; Hamer *et al.*, 2003; Kremen, 1992) as they are sensitive to weather, light level changes (Boogs & Murphy, 1997; Kremen, 1992), humidity, atmospheric conditions and temperature changes (Blau, 1980; Brunzel & Elligsen, 1999; Ehrlich *et al.*, 1972; Spitzer, 1997), and also because they have co-evolved and have intimate relationships with plants (Summerville & Crist, 2001).

This study was carried out in a regenerating forest at Maragamuwa (70° 70' N and 80° 65' E), Sri Lanka and in the bordering tropical moist monsoon forest (Intermediate zone) in order to assess the status of the butterfly fauna. Maragamuwa was a eucalypt plantation and in 2005 harvesting of eucalypt forest was started. From the harvested areas, eight hectare blocks have been selected for monitoring for native seedling generation to convert it to a tropical monsoon forest and for carrying out butterfly surveys. In this regenerating forest the maximum height of trees is about 1-1.5 m and it is difficult to categorize trees into canopy levels. In this study we aimed to evaluate butterfly species diversity and species composition in order to identify species of conservation priority and to understand the biodiversity profile of the area in order to design better forest regeneration practices.

Materials and methods

Butterfly Sampling and Identification

This study was carried out from July 2009 to February 2010 using the timed, directed, fixed distance transect method in natural forest and regenerating forest (Caldas & Robbins, 2003; Walpole & Sheldon,1999) Transects were 100 m in length and were permanently established. While walking along transect, butterflies seen across a 5 m distance from either side of the mid-line were recorded. Three 100 m transects were sampled for each habitat and 30 minutes were spent in each transect. A pair of binoculars was used to identify butterflies seen along transects and a hand lens was used for closer identification if necessary. Field identification of butterflies was done using standard guides, such as those of D'Abrera, (1998) and Gamage (2007). Unidentified butterflies were collected using an aerial insect net and were released in to the same habitat after confirming their identity.

Statistical Analysis

Species diversity was calculated using Shannon diversity index ($H' = -\sum P_i \ln P_i$) and Shannon evenness was calculated using the formula; $E = H' / \ln S$, where, H' = Shannon diversity index, and P_i = Proportional abundance of the i^{th} species, E = Shannon evenness and S = Total number of species in habitat (species richness) (Magurran 1988). A two-sample t-test using MINITAB 15 version was performed (95% confidence interval) to compare whether the difference in monthly abundance, diversity indices and number of species in the two forest types is significant or due to chance

Results and discussion

The present survey recorded 83 butterfly species from six butterfly families. All six families were recorded from the natural forest, while five were found in regenerating forest. Natural forest and regenerating forest were represented by 73 species (1029 individuals) and 60 species (2899 individuals), respectively. Even though the total number of species found in natural forest was higher than in the regenerating forest, the number of individuals recorded in natural forest was lower than in the regenerating forest (Figures 1 and 2). According to the two-sample t-test, there was a significant difference in abundance between the two forest types (P = 0.028).

The higher number of species in the natural forest suggests that favourable conditions for more butterfly species are available in the natural forest. Hamer *et al*. (2003) indicated that the butterfly assemblages in primary and logged forest were different due to habitat preferences of the various species. However, the highest total number of individuals present in regenerating forest suggests that the secondary growth might provide more food resources for certain species of butterflies than natural forest.

Table 1. Number of species in Sri Lanka and each habitat by family.

Family	Number of Species		
	Sri Lanka	Natural Forest	Regenerating Forest
Papilionidae	15	11	6
Pieridae	28	16	15
Nymphalidae	69	23	20
Lycaenidae	85	14	12
Riodinidae	1	1	-
Hesperiidae	46	8	7
Total	245	73	60

The number of individuals recorded of *Catopsilia pyranthe, Junonia almana, Junonia iphita, Junonia lemonias* and *Neptis hylas* species significantly higher in regenerating forest than in natural forest. Therefore, the major habitat preference for these species is regenerating forest. Twenty butterfly species were recorded only in the natural forest and were absent in the regenerating forest. This may be due to the chance. *Euploea klugii , Euploea sylvester, Melanitis leda, Mycalesis mineus, Nissanga patnia* and *Tirumala septentrionis* were absent from regenerating forest, and these taxa are typical averse to sunshine (Wikramanayake & Wikramanayake, 2006). Therefore the absence of these taxa in the regenerating forest may be because of the nonexistence of shaded understory. *Graphium agamemnon, Graphium sarpedon, Papilio crino, Papilio polymnestor* and *Troides darsius* were missed in the regenerating forest and they were recorded at the canopy of the natural forest. As the Papilionoidae are strong fliers, swift and practically impossible to keep pace with (Wikramanayake & Wikramanayake, 2006) perhaps this species constriction could occur due to the absence of canopy in the regenerating forest.

Table 2. Diversity indices of butterfly species in natural forest and regenerating forest.

Indices	Natural Forest	Regenerating Forest
Species richness		
S	73	60
Species diversity		
H'	3.636	3.482
Species evenness		
E	0.847	0.851

Of the 15 Papilionidae species recorded in Sri Lanka, 11 (>70%) were here observed in natural forest and only six species (= 40%) were found in regenerating forest (Table 1). In the natural forest, the Riodinidae showed a 100% representation of Sri Lankan species, while Papilionidae and Pieridae both had more than

50%, and the Nymphalidae, Lycaenidae and Hesperiidae were all represented by less than 50% of the total species recorded in Sri Lanka (Table 1). However, when considering the regenerating forest, only the Pieridae was represented by more than 50% of the total species known in Sri Lanka and the Riodinidae was not recorded (Table 1).

In terms of diversity (Table 2), results indicated that the total number of species was different in natural and regenerating forest. The Shannon diversity index indicated that species diversity was slightly higher in natural forest (H'=3.636) than in the regenerating forest (H'=3.482), although for species evenness the distribution of individuals amongst species was similar in both forest types. However, even in the case of diversity, these differences were slight and, according to the two-sample t-test, there was no significant difference between the two forest types in terms of evenness (P = 0.555), richness (P = 0.501) or diversity (P = 0.529).

Conclusion

The presence of 83 butterfly species indicates that both natural and regenerating forests are rich in butterfly diversity and both provide important habitats for butterflies and therefore warrants protection. Since both natural forest and regenerating forest share some of the same butterfly populations, it can stated that regenerating forest also supports important butterfly diversity in the area. The results from this study lead us to recommend that the long term monitoring and conservation of regenerating forest will assist the conservation of biodiversity by reducing the effects of habitat fragmentation and population loss.

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