

Ecology of butterflies in natural and selectively logged forests of northern Borneo: the importance of habitat heterogeneity

Abstract

1. The impacts of habitat disturbance on biodiversity within tropical forests are an area of current concern but are poorly understood and difficult to predict. This is due in part to a poor understanding of how species respond to natural variation in environmental conditions within primary forest and how these conditions alter following anthropogenic disturbance. Within this context, the main aim of this study was to test the hypothesis that the gap and shade preferences of fruit-feeding butterflies in primary forest in northern Borneo can be used to predict species' responses to selective logging and thus explain changes in diversity and geographical distinctness in relation to habitat disturbance.

2. Overall, there was little difference in butterfly diversity between primary forest and forest that had been selectively logged 10-12 years previously. In contrast, there were marked differences in the composition of the butterfly assemblages in the two habitats, which were strongly associated with species' gap preferences and geographical distributions. In Satyrinae and Morphinae, those species with higher shade preferences and narrower geographical distributions were most adversely affected by logging, whereas cosmopolitan species with high light preferences benefited from logging. In Nymphalinae and Charaxinae the opposite was observed: those species with wider geographical distributions were adversely affected and those species with relatively restricted distributions were more common in logged forest.

3. These changes in butterfly assemblages were associated with changes in vegetation structure following selective logging, which resulted in much lower habitat heterogeneity with less dense shade and fewer open gaps in logged forest. Areas of dense shade, which were more common in unlogged forest, supported species of Satyrinae and Morphinae with restricted geographical distributions, whereas open gaps, which were also more common in unlogged forest, attracted widespread species of Nymphalinae and

Charaxinae. These butterfly-habitat associations in primary forest explain the opposite responses of the two groups of butterflies to selective logging.

4. Synthesis and applications. This study highlights the need to sample at a sufficiently large spatial scale to account for impacts of disturbance on heterogeneity in forest environments. It also demonstrates how understanding the responses of species to natural variation in environmental conditions within undisturbed forest is crucial to interpreting responses of species to anthropogenic habitat modification. The results further indicate that selectively logged forests can make an important contribution to the conservation of tropical biodiversity, provided that they are managed in a way that maintains environmental heterogeneity.