Impacts of rain forest fragmentation on butterflies in northern Borneo: species richness, turnover and the value of small fragments

ABSTRACT

- 1. Widespread and rapid losses of tropical rain forests have made understanding the responses of species to rain forest fragmentation an area of major concern. In this study we examined the impacts of habitat fragmentation on the species richness and faunal composition of butterflies in tropical rain forests in Sabah, Borneo. We analysed patterns of both α- and β-diversity to assess the relative importance of differences in patch size, isolation and vegetation structure on the diversity and similarity of species assemblages. We used additive partitioning to assess the relative contributions of intact forest and forest remnants to overall species richness at a landscape scale and we examined which traits of species best predicted their responses to fragmentation.
- 2. Species richness and diversity in rain forest remnants was significantly positively related to remnant size and significantly negatively related to isolation, in keeping with theories of island biogeography. Species assemblages at different sites were significantly nested, with those species most adversely affected by forest fragmentation having a narrow range of larval host-plants and, to a lesser extent, being large-bodied. No species endemic to Borneo was recorded in forest remnants smaller than 4000 ha, but even the smallest remnant (120 ha) supported species with geographical distributions confined within Sundaland (West Malaysia and the islands of the Sunda Shelf).
- 3. Although assemblages were significantly nested, they departed substantially from perfect nestedness, with some species recorded only or predominantly in small, relatively depauperate remnants. As a result there was substantial β-diversity among sites, which was related to variation in both fragment size and vegetation structure. At the landscape scale, diversity within sites was less than that between sites, and the majority of the diversity between sites was related to variation in fragment size.

- 4. *Synthesis and applications*. Substantial diversity was added to the assemblage of butterflies in Bornean rain forests by virtue of species differences among fragments, which were related mainly to differences in patch size and vegetation structure. The data reported indicate that, despite having lower species richness, relatively small and isolated remnants of rain forest make a substantial contribution to regional diversity. Small isolated forest remnants are generally accorded low conservation status and given little protection, with the result that they often disappear over time because of continued anthropogenic disturbance. The results of this study indicate that the conservation value of small remnants of forest, in particular their contribution to environmental heterogeneity, should not be overlooked.