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EFFECTS OF SHIFTING CULTIVATION ON UNDERSTOREY RAINFOREST BUTTERFLIES OF SARAWAK, BORNEO**Ben H. Warren, David C. Dale, Thomas R.K. Edwards and Patrick B. Hamilton****ABSTRACT**

The effects of shifting cultivation on an understorey butterfly community in Sarawak, Borneo, were assessed by comparing the species composition of primary forest with areas subjected to shifting cultivation at various known times in the past. Species richness projected to 50 hours of sampling effort is highest in primary forest, lowest in young secondary forest of 15-24 years since cultivation, while old secondary forest cultivated 100 or more years ago has intermediate values. Butterflies in most groups analysed are more abundant in primary forest than secondary forest, although a few groups show the opposite trend. When comparing the biogeographic ranges of species, the proportion of species restricted to primary and old secondary forest is highest amongst species with a high level of endemism, while species found in young secondary forest tend to have larger ranges. While primary forest appears to have the highest conservation value for butterflies, old secondary forest is also important. Conservation implications and the need for further work are discussed.

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1. Introduction

A key issue of current concern is the threat to global biodiversity through disturbance of tropical forests (Sutton and Collins, 1991). It is widely accepted that over half of global

diversity in terms of numbers of species is represented by insects (Stork, 1991). Borneo has a diverse insect fauna which is still poorly known (Collins *et al.*, 1991).

South-East Asian rainforests are known to have a long history of disturbance. Extensive removal of forests for agriculture has occurred in South-East Asia for at least 5,000 years, possibly 7,000 or even 9,000 years (Flenley, 1988). Perturbations also occur without the intervention of humans (Johns, 1986). However, the effects of human disturbance have increased greatly over a very short period of time. In the case of Sarawak, technological advances have allowed the timber industry to spread through much of the interior, while the effects of shifting cultivation have increased since rural people have had access to outboard motors and logging roads which facilitate travel, and chainsaws which enable them to clear large areas of forest for cultivation (Bennett and Dahaban, 1995). Shifting cultivation covered 30,000 square kilometres (24%) of Sarawak in 1992, with 1,500 square kilometres cleared annually (IUCN, 1992). Secondary forests, agriculture and urban lands are currently thought to cover 33% of the total land area (Sarawak Government Homepage, 1999, http://www.sarawak.gov.my/sarawak_online/forestry/index.html).

While the effects of tropical forest disturbance on birds and mammals have received considerable attention, very little is known of the effect that disturbance may have on invertebrates, and this subject is in need of further investigation (Whitmore, 1998). Butterflies are a suitable insect group for ecological studies because their taxonomy is well known (in comparison with other insect groups), and there are some data available on their geographic distributions (Spitzer *et al.*, 1993). They are also fairly diverse (but not too diverse for relatively complete assessment), day-flying, conspicuous, and widespread (New, 1991). The dependence of the larval stage on a particular host plant, their role as pollinators, and their sensitivity to changes in temperature and light levels mean that butterflies are good

indicators of the health of their habitats (Ehrlich, 1984; Wood and Gillman, 1998).

The aim of this paper is to assess the effects of shifting cultivation on a Bornean butterfly community by comparing the butterfly fauna of primary forest with areas which have been subject to shifting cultivation at various known times in the past.

2. Methods

2.1. Study area and sampling

The study was carried out between 2 August and 26 September 1998, in and on the edge of Lanjak-Entimau Wildlife Sanctuary (1°25'N, 112°03'E) in southern Sarawak (western Borneo), Malaysia, at an altitude of around 350 m asl. The area is dominated by mixed dipterocarp forest with varying degrees of disturbance (Meredith, 1995).

Butterflies were collected at several localities in order to familiarise observers with the identification of as many species as possible, and establish a reference collection (this is now held by the Sarawak Forest Department at the Forest Research Centre, Kuching). All data presented here were collected at two localities – Nanga Sefera and Geronggang, which are 4 km apart at the head of the river Engkari on the southern edge of the sanctuary (Fig. 1). Both localities included secondary forest with a range of ages since the last period of cultivation, plus primary forest.

The head man from the nearest community had an accurate knowledge of the number of years since cultivation of areas which had been cultivated during his lifetime, and was able to give estimates for older areas. At Nanga Sefera we surveyed forest areas of 16, 24, and 100 or more years since cultivation – hereinafter referred to as NS-16, NS-24, and NS-100 respectively, plus one area cleared as a helipad one year before (NS-1). At