Insect diversity responses to forest conversion and agroforestry management

Merijn M. Bos[1*], Patrick Höhn[1], Shahabuddin Saleh[2], Boris Büche[1], Damayanti Buchori[3], Ingolf Steffan-Dewenter[1], and TejaTscharntke[1]

[1] Agroecology, University of Göttingen, Waldweg 26, D-37073 Göttingen, Germany
[2] Faculty of Agriculture, University of Tadulako, Kampus Bumi Tadulako Tondo, Palu-Indonesia
[3] Department of Pest and Plant Diseases, Faculty of Agriculture IPB, Bogor Agricultural University, Jl. Kamper Kampus, IPB Darmaga, Bogor 16680, Indonesia

*corresponding author: Merijn Bos, Email: boommarter@hotmail.com

Summary

The ongoing loss of pristine tropical rainforests increases the potential importance of agroforestry systems for the conservation of tropical arthropod diversity. Shaded agroforestry systems can still support high levels of biodiversity, even resembling those supported by undisturbed forests, but intensively managed open agroforestry systems may cause severe losses in insect diversity. In this study we evaluate the conservation value of agroforestry systems for species richness and diversity (Simpson's index) of four insect groups at natural forest sites and three different types of cacao-dominated agroforestry systems in Central Sulawesi, Indonesia. The agroforestry systems were characterised by low, intermediate and high diversity of shade trees. Each habitat type was studied with 4 replicates, i.e. 16 study sites altogether. We compared responses of solitary bees and wasps, dung beetles and lower canopy dwelling beetles and ants. These taxa represent diverse and functionally important insect groups: solitary bees and wasps act as crop pollinators or pest predators, dung beetles as decomposers of mammalian excrements and canopy dwelling beetles and ants include abundant herbivores and predators. High percentages of forest species did not occur in agroforestry systems, but diversity and species richness in agroforests remained as high as or even higher than in the forest lower canopy. Diversity, species richness and abundance of the functionally important dung beetles and canopy ants showed strong resilience against both forest conversion and changes in agroforestry management. Diversity, species richness and abundance of solitary bees and wasps as well as

Tscharntke T, Leuschner C, Zeller M, Guhardja E, Bidin A (eds), The stability of tropical rainforest margins, linking ecological, economic and social constraints of land use and conservation, Springer Verlag Berlin 2007, pp 279-296

canopy beetles even seemed to profit from the effects of opening the upper canopy that was related to forest conversion and changes in shade tree compositions. On the latter two groups the effects of opening the upper canopy were stronger than effects of reduced shade tree richness. Based on our results, we recommend the inclusion of agroforestry systems with a diversity of shade trees in tropical conservation plans in addition to pristine forest reserves. Furthermore, regional differences in local agroforestry management contributed to between 31% (for dung beetles) and 58% (for canopy beetles) of the total species richness, which stresses the importance of conservation policies aimed at a diversity of habitat types on a broader landscape scale.

Keywords: agroforestry, ants, beetles, biodiversity, lower canopy, conservation, habitat preference, knockdown fogging, management, pit-fall traps, solitary bees , solitary wasps, trap nests

1 Introduction

The global-scale conversion of natural ecosystems is a major cause of biodiversity loss and threatens ecosystem functioning, sustainable land use and economies (Hoekstra et al. 2005). Tropical rainforests are one of the most species-rich and functionally important terrestrial ecosystems (Myers et al. 2000). In the past 50 years an estimated 32% of these tropical rainforests have been converted to human-dominated systems and a further loss of 10-15% has been projected by 2050 (Millenium Ecosystem Assessment 2005). Hot spots of tropical rainforest conversion are Southeast Asia, with annual deforestation rates of 2.5 million hectares (0.91%) and Central America, with 2.5 million ha (0.38%) per year (Achard et al. 2002). With the continuing loss of tropical forests, cultivated areas are gaining interest for their potential value for conserving tropical biodiversity. Diversified agricultural systems such as agroforestry are suggested to serve as tools in nature conservation policies (Rice and Greenberg 2000; Putz et al. 2001; Donald 2004; McNeely 2004; Schroth et al. 2004).

1.1 The conservation potential of agroforestry systems

Agroforestry systems are generally characterized by a canopy cover of shade trees below which a wide range of crop plants can be grown (Schroth et al. 2004). In human-dominated, deforested landscapes, agroforestry systems provide the only remaining habitat type with a substantial tree cover (Schroth et al. 2004). Agroforestry supports some of the most important tropical cash crops including oil palm (*Elaeis* spp), rubber (*Ficus elastica*), cacao (*Theobroma cacao*) and coffee (*Coffea* spp.). Additionally, various kinds of timber, local fruit trees and annual crops are grown in agroforestry systems, thereby