

Impact of Forest Disturbance and Land Use Change on Soil and Litter Arthropod Assemblages in Tropical Rainforest Margins

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Abstract

Land use intensification at rainforest margins increases the pressure on the primary rainforest ecosystem, known for its high biodiversity and important functional role in global climate and carbon balances. Studying this system at different levels of disturbance increases our knowledge about its stability and mechanisms of diversity changes. While most studies investigating the effects of disturbance on animal populations focus on canopy communities, the present study reviews the driving factors for soil and litter arthropod communities. In addition, results from a study along a land use gradient in Central Sulawesi (Indonesia) will be discussed.

Within natural forests, litter composition, patchiness and especially litter abundance seem to be key factors driving litter arthropod diversity and densities, by creating microhabitats for many species and individuals. With increasing levels of disturbance in tropical forests, and with forest conversion into agroforestry and agricultural systems, soil/litter temperature and moisture levels become extremely important, leading to reduced densities and species richness. Changes of soil pH, a reduction of the litter habitat and increased anthropogenic disturbance via site management practices add to degradation. In the present study, litter arthropod communities were compared between three levels of forest use (none, small and large timber extraction) and two types of cacao plantations (under natural shade trees and under a polyculture of planted shade trees). The negative effects of increasing gap fraction and thus increasing temperatures accompanied by decreasing moisture levels and litter depth could be confirmed. Abundances of Collembola, Oribatida and Symphyla in litter and soil and the number of ant species in the litter declined with increasing land use intensity. In contrast, spider density and ant activity increased when natural forest sites were compared with the two types of cacao plantations. This can be explained by the shifting community structure of these two taxa, indicating that few, but abundant species of open habitats, such as Lycosidae, were replacing forest species. Surprisingly, the decline in microarthropod abundances along the land use gradient was not linearly correlated with decreasing moisture and litter depth or increasing temperature or litter quality (C-to-N ratio). Rather low microarthropod densities were already measured in little disturbed natural forest sites with small timber extraction. A similar pattern was observed for fungal abundances and root production, indicating that even small levels of disturbance influence the litter and soil system in tropical forests. On the one hand, changing microclimate, limited litter space, reduced availability of microbial resources and increased disturbance by plot maintenance inhibit higher densities of litter and soil animal populations. On the other hand, the simplified habitat structure favours populations of open habitats, especially predatory groups adapted to higher temperatures

and/or lower soil moisture. It has to be investigated how a reduction of decomposers and an increase in predators could influence pest control and thus yields in these agroforestry systems.

Keywords: ants - cacao plantations - disturbance - forest conversion - litter arthropods - litter habitat - microarthropods - moisture - rainforest - shade trees - soil fauna - spiders - temperature