



Influence of local illumination and plant composition on the spatial and seasonal distribution of litter-dwelling arthropods in a tropical rainforest

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Soil;
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Summary

Using pitfall traps, we evaluated the spatial and seasonal variance in arthropod abundance, species richness, higher taxonomic and species composition, and guild structure within the ground litter of seven sites in a relatively undisturbed rainforest in Panama. We examined each of these five arthropod-dependent variables at two spatial scales (a few meters and a few hundred meters) and one temporal scale (a few months encompassing dry and wet periods), against environmental variables including local illumination and plant composition. Trap catches (9458 arthropods collected during 630 trap-days) were high compared to similar studies in temperate

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forests. We observed spatial and seasonal differences in abundance, species richness and composition of litter-dwelling arthropods. Often these differences appeared weakly related to geographical coordinates. They reflected forest structure (basal area) and local plant composition, and less so illumination patterns or seasonal changes in radiation. Seasonal variance was high and may relate to surrogate variables accounting for seasonal changes in litter moisture. The composition of higher taxa and species was often predicted by different independent variables at the three scales studied. Guild structure was difficult to predict. Our study lead us to expect that litter-dwelling arthropods may be more seasonal than soil microarthropods in tropical rainforests; and that tropical litter-dwelling arthropods may also be more spatially variable and seasonal than their temperate counterparts. We also recommend that conservation studies using pitfall traps in tropical rainforests should focus on: (1) taxonomic resolution to understand the functional complexity of soil organisms; (2) spatial replication to address subtle changes in plant composition throughout the study area; and (3) seasonal replicates to be commensurate with seasonal changes in litter moisture.

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Introduction

The microgeographic distribution of arthropods, their sheer number and short generation span make them ideal organisms for biodiversity monitoring (Mattoni et al., 2000). The arthropod component of the soil/litter fauna appears particularly important in this context, since it is involved in crucial processes of ecosystem functioning, such as decomposition and nutrient cycling (Wolters, 2001). The soil/litter interface of tropical and temperate forests differ in several aspects: tropical soils are usually N-rich and P-poor, as opposed to the N-poor and P-rich soils of temperate forests; the amount of litterfall in tropical rainforests is usually high and may occur year-long; and decomposition rates are also twice as fast in tropical forests than in temperate forests, and the primary decomposers are predominantly fungi (Beck, 1971; Takeda and Abe, 2001; McGroddy et al., 2004). Thus, the organic layer of tropical forests is composed mainly of freshly fallen litter and a poorly developed humus horizon. In both tropical and temperate forests, food resources for soil/litter animals include mainly fresh litter, live fungi and dead organic matter; however, many animals feed on fungi in tropical forests (Beck, 1971; Takeda and Abe, 2001). As a result, litter and fungal feeders are more abundant in tropical than temperate forests, but densities of detritus-feeders in the soil are one-order of magnitude lower in tropical than in temperate forests (Beck, 1971; Takeda and Abe, 2001; Wiwatwitaya and Takeda, 2005). Therefore, separate studies of ground litter-dwelling and soil fauna should be conducted especially in the tropics.

The soil/litter fauna remains very poorly studied, particularly in the tropics (André et al., 2002). Studies of local differences in the composition of soil/litter arthropods within old-growth or relatively undisturbed tropical forests are few (Atkin and Proctor, 1988; Burgess et al., 1999; Goehring et al., 2002; Wiwatwitaya and Takeda, 2005). The paucity of studies is primarily due to: (a) the considerable variability in arthropod abundance and species richness, due to the substrate, its past history and disturbance regime, as well as to a suite of abiotic and biotic factors; and (b) the difficulty in extracting, identifying, studying and monitoring focal organisms (Brussaard et al., 1997).

In temperate forests, variability in the distribution of soil/litter arthropods depends mostly on soil humidity, pH and the physical and chemical composition of litter produced by one or a few tree species (Burghouts et al., 1992). In tropical rainforests, similar variability can be explained at the regional scale by altitude, soil nutrients and disturbance regime (Atkin and Proctor, 1988; Burghouts et al., 1992; Olson, 1994; Thomas and Proctor, 1997). At the local scale, however, the situation may be confounded by many factors. Since tropical species are often thought to be more habitat-specific than their temperate counterparts (Stevens, 1989) and/or diversity of habitats and microhabitats are higher in tropical forests than in temperate forests (Novotny et al., 2006), highly variable distribution of tropical soil/litter arthropods may be expected, even at the scale of a few meters (Kaspari, 1996).

Soil/litter moisture content, illumination, topography, canopy structure (affecting illumination and evaporation), standing crop litter, litter fall

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