Deutscher Tropentag, October 8-10, 2003, Göttingen

"Technological and Institutional Innovations
for Sustainable Rural Development"

Spatial Patterns of N_2-Fixing Legumes in Secondary Forests

Christoph Gehring, Soojin Park, Manfred Denich, Paul L. G. Vlek

University of Bonn, Center for Development Research (ZEF), Germany

Abstract

Slash-and-burn agriculture relies on the regeneration dynamics of secondary fallow regrowth to recuperate the productive potential lost in the burn and short cultivation-phase. Losses are particularly heavy for nitrogen, both to the atmosphere and via nitrate leaching. Biological nitrogen fixation (BNF) by legume-rhizobia symbiosis is the main pathway for secondary forests to recuperate these losses and satisfy N-needs during the biomass buildup. However, our knowledge on BNF remains insecure, since the ^{15}N natural abundance method fails to quantitatively estimate BNF in tropical forests. Research on BNF needs to meet with the heterogeneity and complexity of these forests, the present study pursues the spatial pattern of legume-BNF along secondary forest succession.

Research was conducted in a 15-site (7.9 ha) chronosequence of 2- to 25-yr.-old fallow regrowth in Central Amazonia. We mapped all legume plants >50 cm height, allometrically estimated their biomass, and identified >98 % of them to the species-level. Foliar $\delta^{15}N$-signals of potentially N_2-fixing legumes and of selected non-legume species were obtained by spatially systematic sampling.

Visual assessment of maps reveals an irregular distribution of potentially N_2-fixing legumes throughout succession and suggests clustering at short to mid distances and random distribution beyond. Point pattern analysis confirms these observations, indicating maximum clustering at 5–10 m distance on all sites and for most species. Legume vegetation is organized at the species-level and species-grouping by genus or growth form obscures such patterns. Spatial organization apparently also changes systematically along succession, as demonstrated for the common liana species *Machaerium hoehneanum* Ducke (Papilionoideae).

The spatially aggregated distribution of potentially N_2-fixing legumes gives room to the hypothesis that BNF is likewise irregularly distributed. We investigate the spatial pattern of BNF by interpolating the foliar $\delta^{15}N$-signals of potentially N_2-fixing legumes and of non-legume reference plants. The resulting BNF-estimates are irrelevant in absolute terms, but nevertheless indicate that BNF is concentrated in small to mid-sized 'hotspots'. Such BNF hotspots are expected to affect vegetation and topsoil in their surroundings and to form microsites with elevated N-turnover.

Keywords: Biological nitrogen fixation, capoeira, legume, nodulation

Contact Address: Christoph Gehring, University of Bonn, Center for Development Research (ZEF), Walter-Flex-Straße 3, 53113 Bonn, Germany, e-mail: c.gehring@uni-bonn.de