Correlated changes of wood stick decomposition with local environmental factors in a forest dynamics plot at Lambir Hills National Park, Sarawak

Sanae MORI[1*], Satoshi NANAMI[1], Akira ITOH[1], Takuo YAMAKURA[1], Sylvester TAN[2], Lucy CHONG[2]

[1] Laboratory of Plant Ecology, Graduate School of Science, Osaka City University, Osaka, Japan
[2] Sarawak Forestry Corporation, Kuching, Sarawak, Malaysia

Introduction

The decomposition rate of soil organic matter with litterfall origin in forest ecosystems is highly correlative with soil temperature, soil water (Swift 1979, Jordan 1985), quality and size of decomposed organic matter (Yoneda 1980), and other factors. Because soil temperature and soil water can vary in local scales together with soil texture, topography, stand flora and structure, the decomposition is also expected to vary in local scale. But spatial variation of decomposition has scarcely been investigated in rainforests. In this study, we have attempted to quantify the local variation of decomposition rate in a rainforest at Lambir Hills National Park, Sarawak. We have also tried to solve some ecological questions about the mosaic pattern of local decomposition rates and its correlation to the local environmental factors such as topography, soil texture, and so forth, by analysing the observed decomposition rate.

Methods

A 52-ha plot (500 m × 1040 m) was established in the Lambir Hills National Park (4°12′N, 114°00′E; ~ 60 - 450 m a.s.l.) in Sarawak, East Malaysia. Sample wood sticks were made of *Dryobalanops aromatica* Gaertn. f. The size of each stick was 1.0 cm × 1.0 cm × 15.0 cm. All the sticks were measured for air-dry weight and were labeled with aluminum tags to identify each sample stick. The five sticks were tied in a loop using copper wire and were laid on the forest floor at every 20 m interval i.e. in the center of each of the 1300 squares within the 52-ha plot. One of the five sticks was successively collected at 6, 18, 24 and 34 months interval after the start of the experiment in March 2001. Collected samples were all washed, dried, and measured for their dry weight. The ratio of the dry weight of the collected stick to the initial weight gave the relative decomposition rate.

Analysis and results

Data analyses of the decomposition rate were carried out based on the method developed by Yoneda (1975), who reported a decrease of wood stick weight with respect to time by applying the logistic equation with a negative coefficient for an exponential term of the equation. The frequency distribution of the wood decomposition coefficients was a reverse J-shape. The average and the standard deviation of the wood decomposition coefficients were 0.668 g/g/year and 0.259 g/g/year, respectively. The average, maximum and minimum of the half time ($t_{0.5}$) of decomposition, which were calculated from the wood decomposition coefficients, were 3.02 years, 8.71 years and 0.712 years, respectively. The range of $t_{0.5}$ was about 8 years within the 52-ha plot.

The spatial structure of the wood decomposition coefficient was analysed by a geostatistical method, the semivariogram. The practical range was 80.0 m, which indicated that the distribution was spatially auto-correlated within this spatial scale. The relative nugget was 74.6 %, and this value would suggest that a large contribution of small-scale structure affected the spatial pattern of the wood decomposition coefficients.

The relationships between the environmental factors and the wood decomposition coefficients were analysed by applying Hayashi's quantification method in 100 m × 100 m scale because the spatial auto correlation of the wood decomposition coefficients vanished altogether in this scale. The number of 100 m × 100 m quadrats that we could demarcate inside the 52-ha plot was 1008. There are 25 experimental points within a 100 m × 100 m quadrat, so we calculated the averages of common logarithmic transformed wood decomposition coefficients which were obtained in each experimental point and used them as the 'outside criterions'. Six environmental factors (altitude, slope inclination, slope convexity (IC), soil texture, termite attack, leaf area index (LAI)) were used as 'items'. Arithmetic averages were calculated the same as the wood decomposition coefficients for altitude, slope inclination, IC, soil texture, and LAI. We evaluated the termite foraging effect from the proportion of the number of experimental points, at which the wood stick might be foraged by termites, to 25 experimental points within a 100 m × 100 m quadrat. The results of the model selection by the Akaike Information Criterions (AIC) presented that the most appropriate model was composed of all 'items' we used. The wood decomposition coefficients were relatively well reconstructed by this model (r^2 of the model = 0.55, the number of samples = 1008). The range of the categorical scores for each 'items', which indicated that the order of the strength of their influences on the wood decomposition coefficients, was termite > soil texture > altitude > IC > Inclination > LAI.

REFERENCES

Jordan, C. F., 1985. Nutrient cycling in tropical forest ecosystems, John Wieley and Sons, Chichester

Swift, M.J., Heal, O. M., Anderson, J. W., 1979. Decomposition in terrestrial ecosystems, Oxford, Blackwell Scientific

Yoneda, T., 1975. Studies on the rate of decay of wood litter on the forest floor. II. Dry weight loss and CO_2 evolution of decaying wood, Japanese Journal of Ecology, 25: 132-140

Yoneda, T., 1980. Ecological study of wood decomposition (in Japanese), Doctoral theses, Osaka City University, Osaka