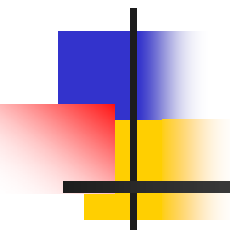


**LITTER DECOMPOSITION AND NUTRIENT RELEASE VIA LITTER
DECOMPOSITION IN TWO SUB-TYPE OF PEAT SWAMP FOREST IN
CENTRAL KALIMANTAN, INDONESIA**

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1. INTRODUCTION
2. MATERIALS AND METHODS
3. RESULTS
4. DISCUSSION
5. CONCLUSION
6. ACKNOWLEDGEMENTS



INTRODUCTION

- *Decomposition of plant litter is a key process in the nutrient cycles of most terrestrial ecosystems*
- *Decomposition is a complex interaction of processes involving several factors.*
- *Litter decomposition rates are controlled by environmental factors, such as pH, climate (temperature, humidity and moisture); the chemical composition of the litter; and by soil organisms*

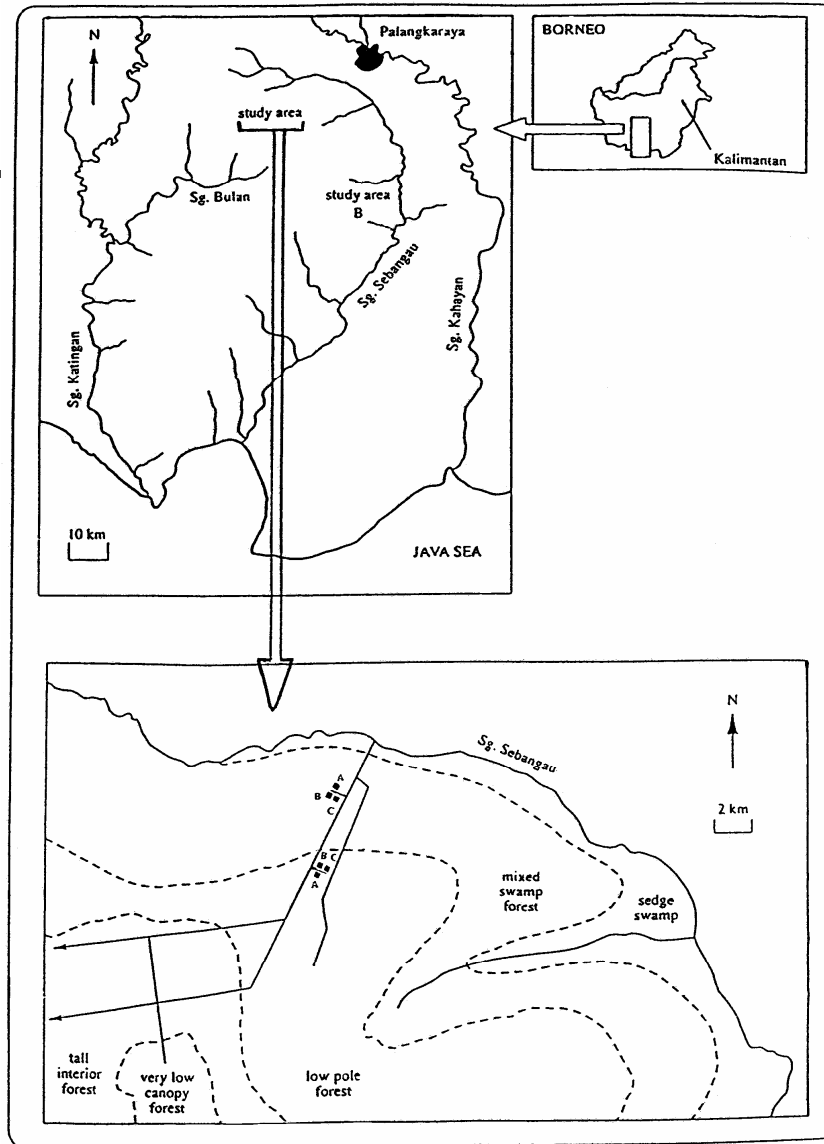


INTRODUCTION

- *In general, the rate of decomposition is less at low pH than at neutral pH.*
- *Organic material with a high C/N ratio is more difficult to decompose than that with a low C/N ratio.*
- *Litter in which the number of soil organisms is high tends to decompose faster than litter with a small number of soil organisms.*
- *Decomposition rates are higher in aerobic conditions than in anaerobic conditions*
- *In general, plant species from nutrient-poor environments produce litter that is more difficult to decompose than litter of species from nutrient-rich environments.*
- *This is because low-nutrient species generally have higher C:N ratios and higher concentrations of decay-resistant (i.e. lignin) plant compounds than high-nutrient species*

MATERIALS AND METHODS

Study site



- five sub-types – riverine forest, mixed swamp forest, low pole forest, tall interior forest, and very low canopy forest type
- focussed in two different sub-types of peat swamp forest, mixed swamp forest and low pole forest

Litterbag prepared for insertion into the forest floor



- The litterbag method was used for the decomposition study
- Every six months (6,12,18 months) 12 litterbag samples were harvested from the study plots (MSF and LPF) and these were air dried, oven dried and weighed. Six litterbag samples were taken from hollows and other six samples from hummocks.

Methods

- The litter dry mass loss and nutrient release were calculated as (Guo & Sims, 1999; Guo & Sims, 2001):

$$L (\%) = \frac{100 (W_o - W_t)}{W_o}$$

- *And*

$$R (\%) = \frac{(W_o C_o - W_t C_t)}{W_o C_o} \times 100$$

- L = litter dry mass loss
- W_o = the initial litter dry mass before the experiment started,
- W_t = dry mass of the remaining litter after t time.
- R = nutrient release;
- C_o = nutrient concentration (mg kg⁻¹) in the initial litter;
- C_t = nutrient concentration (mg kg⁻¹) in the remaining litter.

■ RATE OF DECOMPOSITION

- $W_t = W_o e^{-k t}$
- W_t = dry weight at time t ,
- W_o = the initial leaf litter dry weight
- k = the rate of decomposition constant.

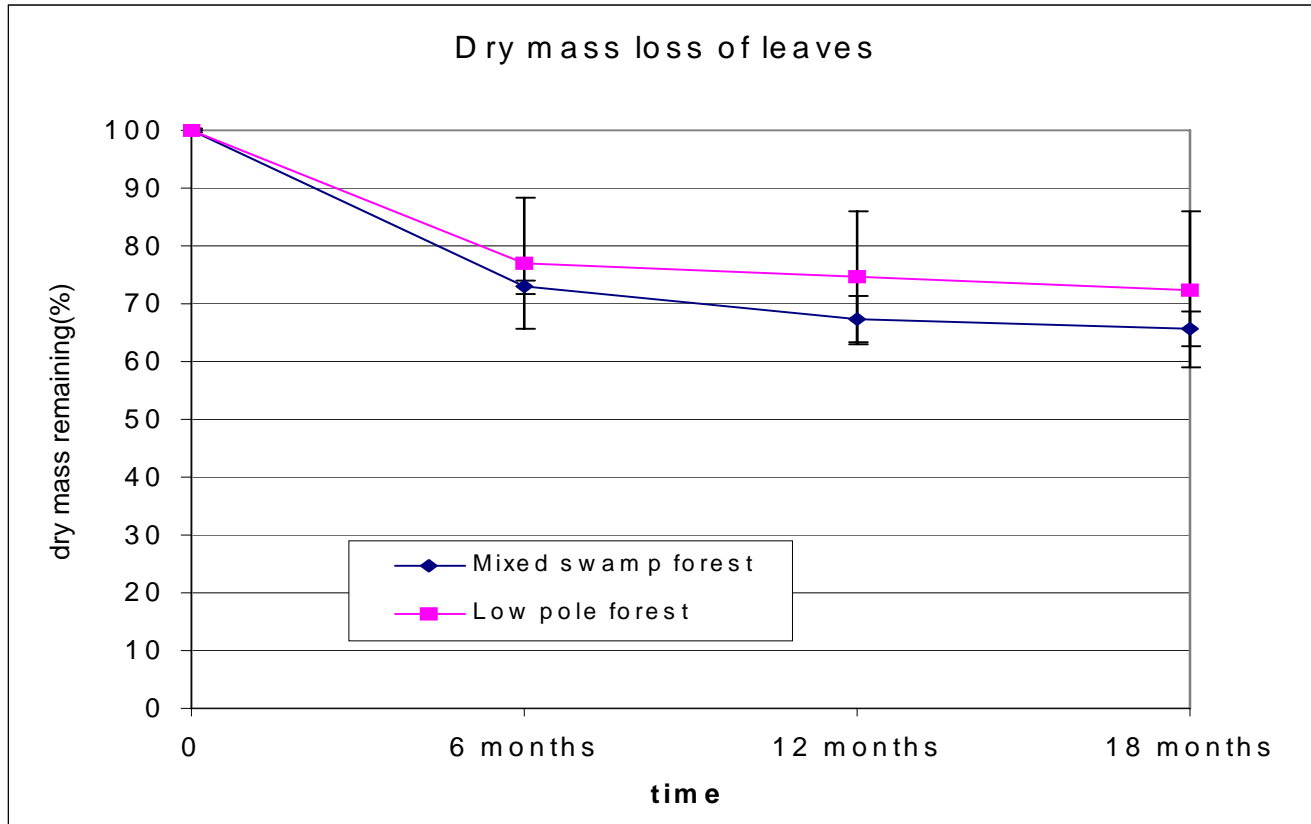
Methods



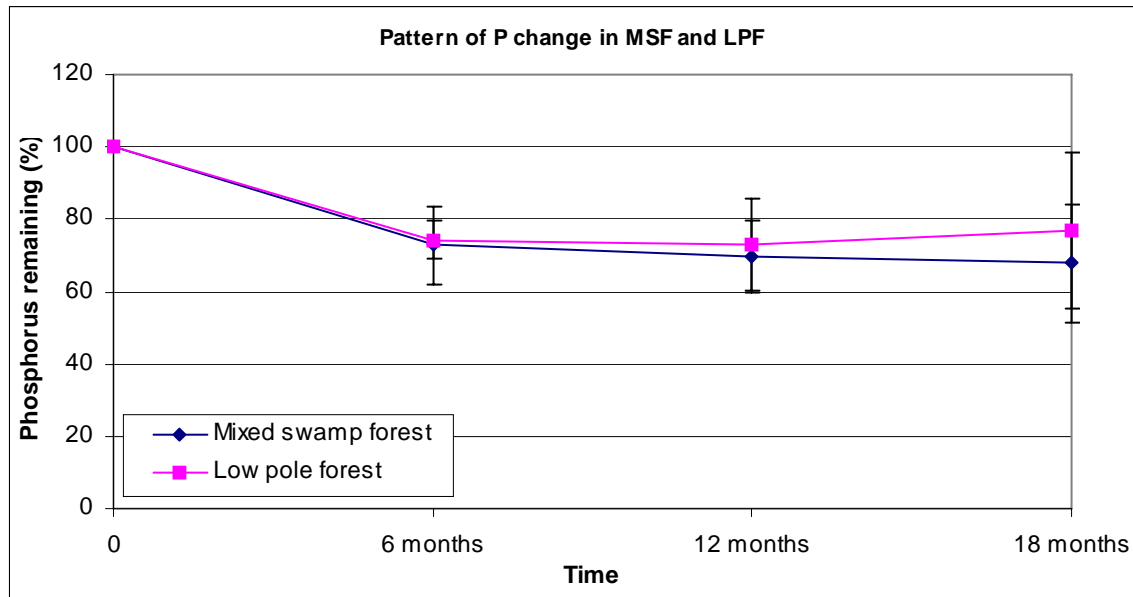
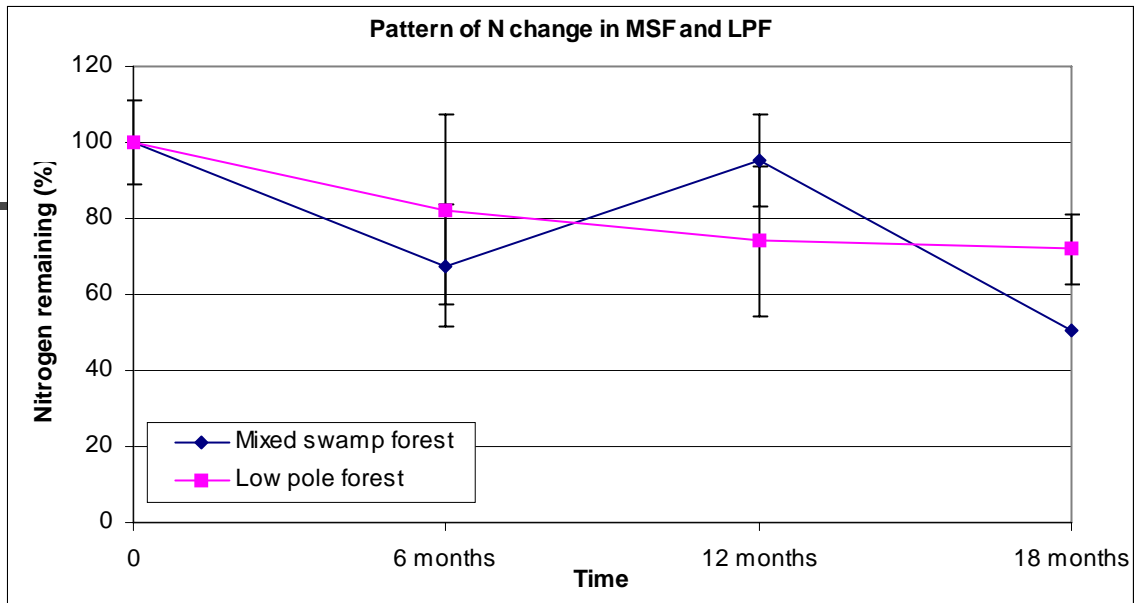
- **Methods for Nutrient Analysis**

- Ca, Mg, K, Na, Fe, and Mn concentration Wet digestion perchloric acid 18 % followed by atomic absorption spectrophotometer (Varian Spectra 30).
- Total phosphorus was determined by the Scheel method
- Total nitrogen was determined persulphate digestion

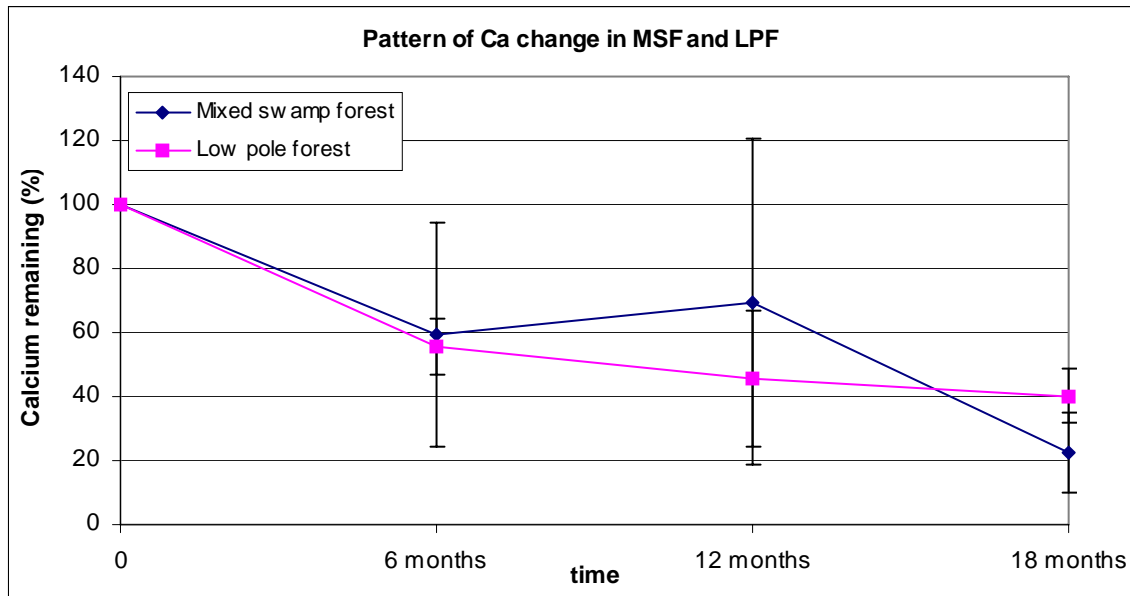
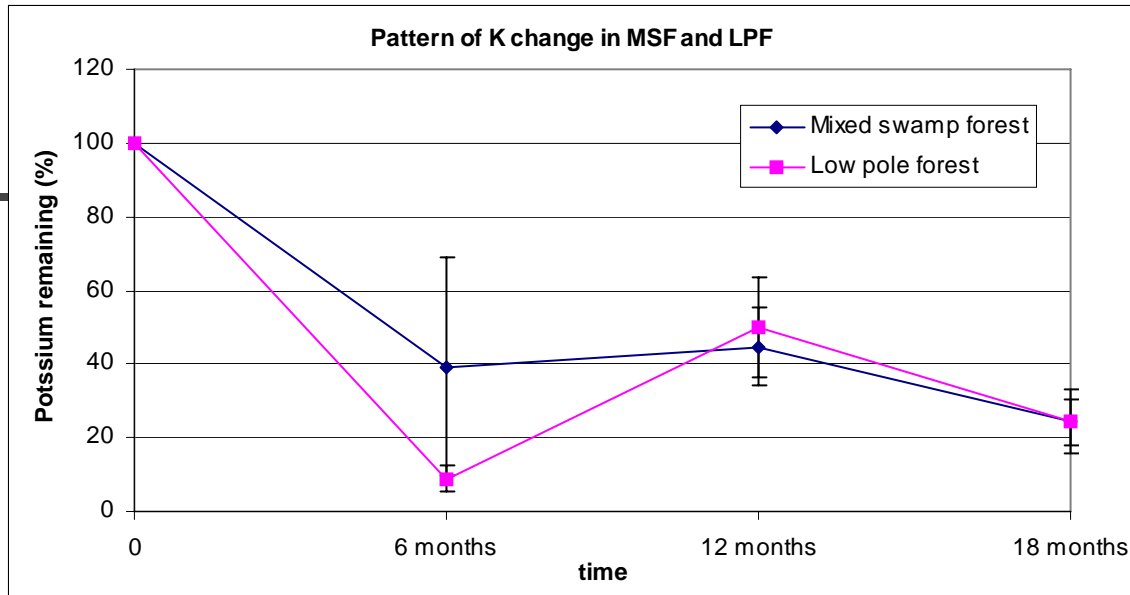
RESULT (Weight loss)



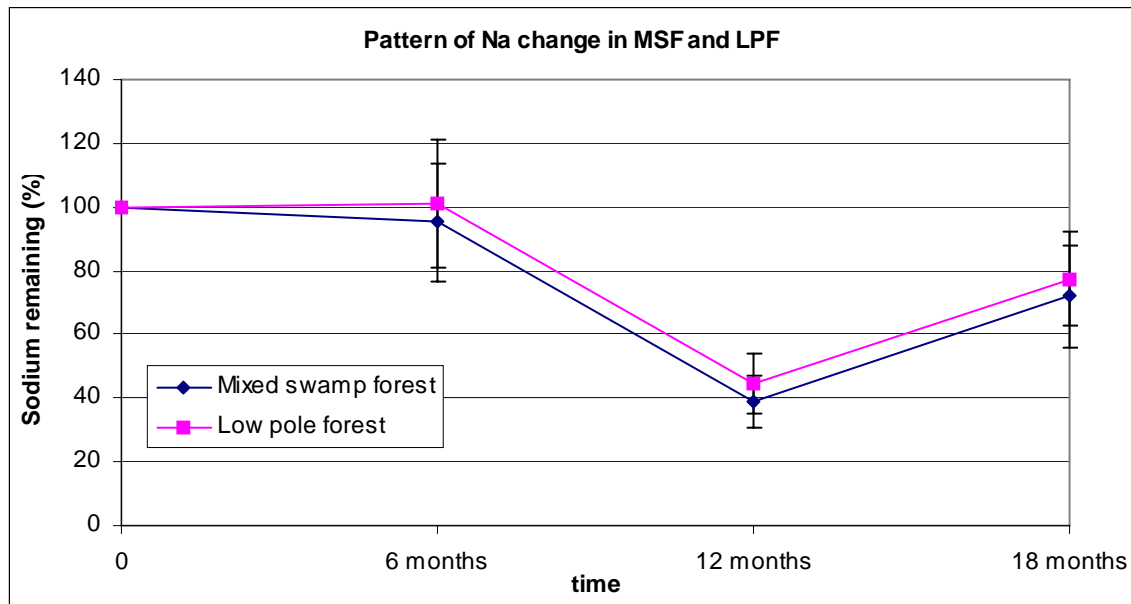
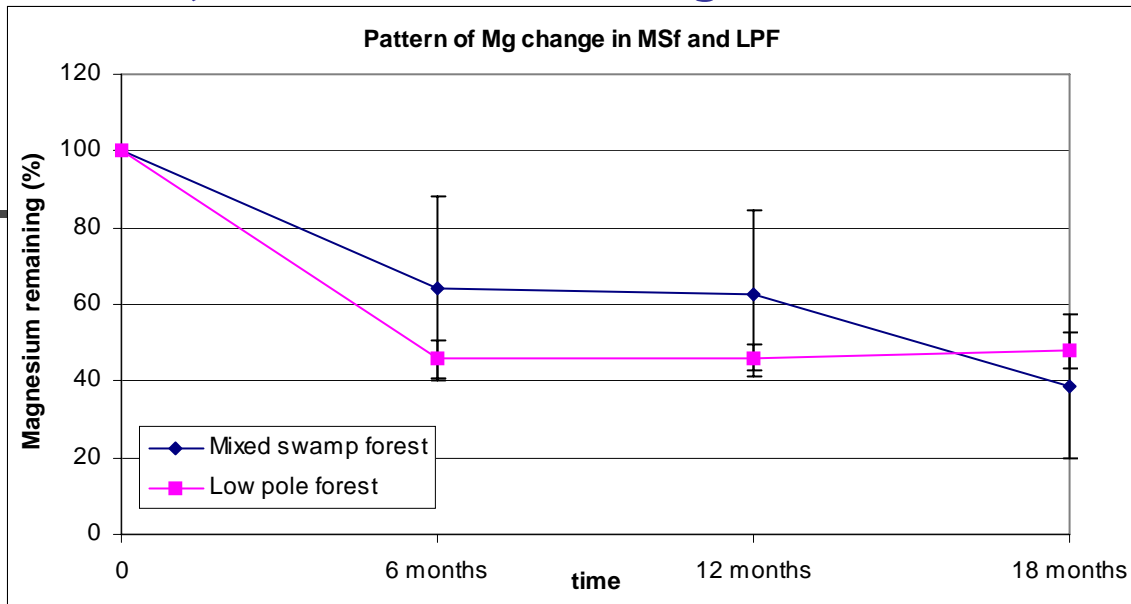
RESULT (Nutrient Loss of N and P)



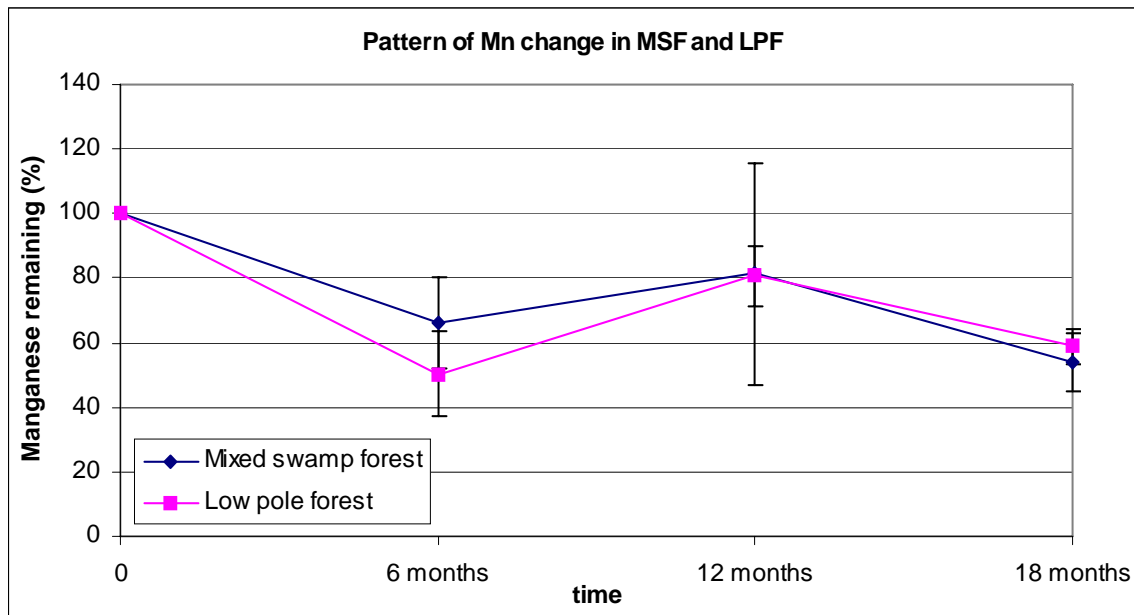
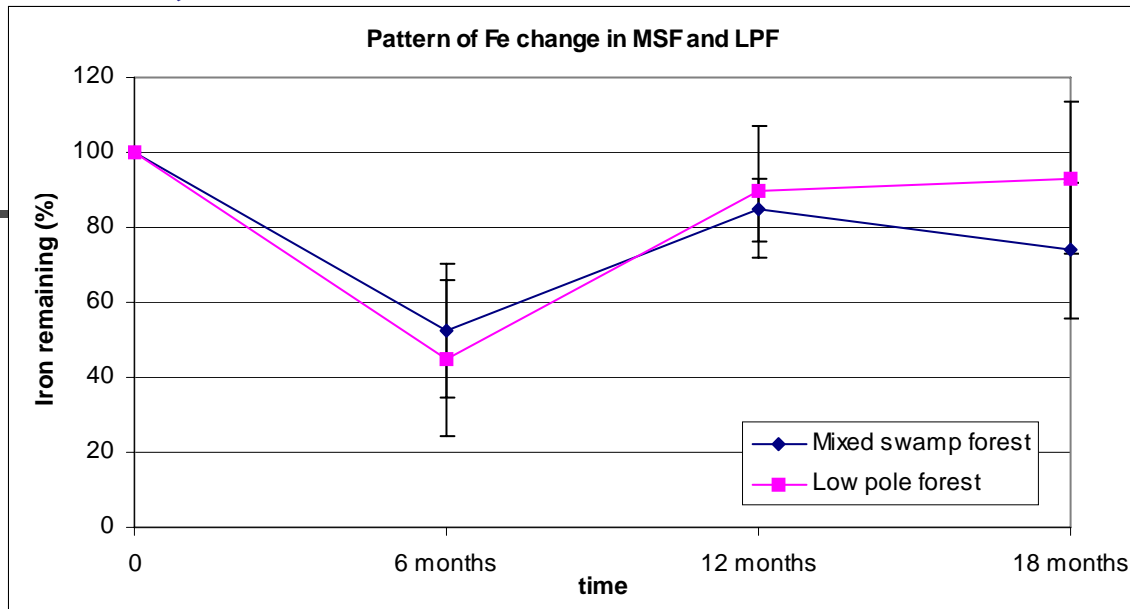
RESULT (Nutrient Loss of K and Ca)



RESULT (Nutrient Loss of Mg and Na)



RESULT (Nutrient Loss of Fe and Mn)





RESULT (Rate of decomposition)

Type of Forest	6 Months (196 days)	12 months (378 days)	18 months (560 days)
Mixed swamp forest	0.605 yr ⁻¹ a	0.396 yr ⁻¹ a	0.814 yr ⁻¹ a
SD	0.288	0.160	0.394
% SD MSF	47.60	40.34	48.39
Low pole forest	0.486 yr ⁻¹ a	0.285 yr ⁻¹ a	0.602 yr ⁻¹ a
SD	0.024	0.053	0.075
% SD LPF	4.91	18.58	12.48

DISCUSSION (Rate of decomposition)

No	Location	Species	k per year	Reference
1	Sebangau, Central Kalimantan, Indonesia (MSF)	Mixed litter	0.396	This study
2	Sebangau, Central Kalimantan, Indonesia (LPF)	Mixed litter	0.285	This study
3	New Guinea	<i>Dysoxylum</i>	2.22	Rogers, 2002
	New Guinea	<i>Celtis</i>	2.12	Rogers, 2002
	New Guinea	Pometia	1.17	Rogers, 2002
4	Lahei, Central Kalimantan, Indonesia	<i>Vatica Oblongivolia</i>	0.292	Rahajoe <i>et al.</i> , 2000
		<i>Buchanania sessilifolia</i>	0.730	Rahajoe <i>et al.</i> , 2000
		<i>Gluta cf laurifolia</i>	0.328	Rahajoe <i>et al.</i> , 2000
		Mix litter	0.438	Rahajoe <i>et al.</i> , 2000
	Heath forest	<i>Calophyllum pulcherrimum</i>	0.438	Rahajoe <i>et al.</i> , 2000
		<i>Tristaniopsis sp</i>	1.423	Rahajoe <i>et al.</i> , 2000
		<i>Palaquium sp</i>	0.547	Rahajoe <i>et al.</i> , 2000



DISCUSSION (Rate of Decomposition)

- Rate of Decomposition is fast in the few week. Physical and biological processes are involved in this stage and most of the loss may be from the water-soluble fraction rather than the lignocellulose fraction.
- Soluble material in leaf litter consists mostly of simple organic compounds, including reducing sugars, phenolic and amino acids
- In MSF the water table was above the peat surface during rainy season while in LPF it was mostly closer to or above the peat surface throughout the year (Page *et al.*, 1999).
- decay was reduced during flooding periods (due to anaerobic conditions)
- The decomposition rate is mainly determined by the activity of microorganisms in a soil as determined by microbial biomass, activity types of microorganisms and environmental conditions (e.g. aerobic or anaerobic condition).



DISCUSSION (Rate of Decomposition)

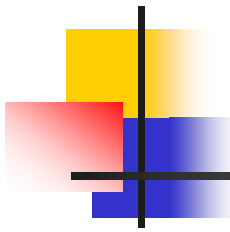
- There are several reasons that could explain the low k values obtained in this study.
- **Firstly**, anaerobic conditions. It is well known that the rate of decomposition is reduced during anaerobic conditions (flooding and permanently high water table) (Brady, 1997; Latter, 1998).
- **Secondly**, evidence suggests that plant species from nutrient-poor environments produce litter that is more difficult to decompose than litter of species from nutrient-rich environments (Murayama & Zahari, 1992; Couteaux *et al.*, 1999).
- **Thirdly**, substrate acidity affects the activity of decomposer microorganisms, including fungi, (Murayama & Zahari, 1992) and the peat soil pH values obtained in this study were low (2.82 – 3.80).



DISCUSSION (Nutrient Loss of K and Mg)

- Potassium is the element most rapidly lost.
- Potassium is a highly mobile element in plants and soil and is readily leached out. The low proportion of K remaining in litter early in the incubation period is consistent with the high mobility of K and its lack of incorporation into organic plant structures
- Magnesium was also lost rapidly in the first 6 months.
- It has been suggested that K and Mg releases do not depend on biotic activity, but are the result of physical leaching .

DISCUSSION (Nutrient loss Ca and N)

- 
- Calcium was also lost rapidly during the first six months
 - Reason: a faster release of calcium (and magnesium) from litter in Amazonia terra firme forest occurred when it was in contact with fine roots, suggesting there must be a nutrient release mechanism that is mediated by these roots and/or their associated microorganisms (Cuevas & Logu, 1998).
 - The losses of nitrogen is slow. One reason given to explain the slow nitrogen release from organic substrates is that it is difficult to obtain a C/N ratio value lower than the critical one of (20-35:1) (Ribeiro *et al.*, 2002)
 - Nitrogen remaining in MSF after six months decomposition increased greatly after 12 months, in common with the results of other studies. Explanations of this apparently anomalous N-increase include addition of N by biological fixation, fungal translocation of N and immobilization.
 - N immobilization is usually attributed to accumulation of microbial protein (Suberkropp *et al.*, 1976) although variations in the tree species comprising the leaf litter sampled at different times during the decomposition studies could also be a factor.



DISCUSSION (Nutrient loss P, Na, Fe and Mn)

- Rapid loss of phosphorus was observed during the first six months of decomposition. P release by both direct leaching and through microbial biomass activity.
- Sodium loss in the litter is relatively slow during the first six months and perhaps sodium is not a leachable element but may be dependent on biotic activity for its release.
- Iron and manganese losses were also incurred during the study period but the absolute values involved were very small (micronutrient).
- Similarly to calcium, manganese was also more dependent on biotic activity than leaching, probably because this element is also bound to plant cell walls (Rogalla & Romheld, 2002).

CONCLUSION



- It seems that differences in decomposition rates in both sub types of forest are controlled by various factors, the most important of which are probably hydrological condition and nutrient availability in an ombrotrophic environment.
- The degree of water saturation, especially in the surface peat, will control decomposition rate through the soil microbial population and the factors that control their activities.
- Rates of decomposition are most rapid under aerobic but moist conditions, and become slower in sites that are continually dry but are slowest in permanently anaerobic areas.
- The most important factor limiting decay rates in natural peatlands are moisture availability and waterlogging, although other factors such as low nutrient concentration and low pH may also be important.
- Future work could also be carried out to compare decomposition processes between hummock and hollow condition in the same sub-type of peat swamp forest.



ACKNOWLEDGEMENTS

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- The author wishes to thank Sampang, Ary, Adi, Edy etc for their cooperation during field works and laboratory analysis.

A photograph of several tall, slender plants with dense clusters of small, light pink flowers. The plants are situated in a greenhouse, with a large window in the background showing a reflection of the plants and some greenery outside. The plants are growing in a bed of brown mulch. In the foreground, there are some green, leafy plants, possibly irises, and a small white sign on a stick is visible. The overall scene is brightly lit, suggesting a sunny day.

THANK YOU FOR YOUR ATTENTION