

DEGRADATION RATE OF LEAF LITTER OF *BRUGUIERA PARVIFLORA* OF MANGROVE FOREST OF KUALA SELANGOR, MALAYSIA

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Abstract : Two exposure methods, leaf litter on string and leaf litter in bag, were used for leaf litter loss due to feeding plus mechanical breakdown and microbial degradation during dry and wet months respectively. Leaves in bags exhibited 48% and 60% of dry weight loss at 120 and 30 days during dry and wet months respectively. Comparatively a higher degradation rate occurred in the initial period of dry and wet months followed by lower rates thereafter. Comparatively a lower rate of leaf litter loss due to feeding plus mechanical breakdown was observed during the initial 5 days of dry and wet months. Relatively higher percentage of leaf litter loss (52.61% to 69.33%) was attributed to feeding plus mechanical breakdown by crabs while the microbial degradation ranged from 30.67% to 47.39%. The rate of microbial degradation found to be affected by dry and wet months but not the litter loss due to feeding plus mechanical breakdown by crabs.

INTRODUCTION

Mangroves are productive ecosystems and have a high rate of primary production. The primary productivity of mangroves seems to vary with the geographical locations and with the tidal amplitudes (Twilley *et al.*, 1986; Woodroffe *et al.*, 1988). Bunt *et al.* (1979) reported that litter fall is about 30-60% of the total primary production and has significant importance on detrital based food webs in the coastal environment and coastal fisheries (Odum and Heald, 1975; Ong *et al.*, 1984; Lee, 1995). The amount of organic matter export to the aquatic ecosystem from the mangroves depends on the litter decomposition rates while decomposition rates depend on the degree and frequency of tidal inundation, climatic and edaphic factors and presence or absence of litter consuming fauna within the mangrove forest (Reice *et al.*, 1984; Valiela *et al.*, 1985; Twilley *et al.*, 1986; Robertson, 1988; Chale, 1993). In general the dynamics of litter breakdown not only vary with species but also geographically (Ashton *et al.*, 1999) and affected by leaf chemical composition like nutrients and lignin content (Tam *et al.*, 1998). Significant amount of nutrients and organic matter are released during the process of mangrove litter decomposition and has an important role in internal nutrient cycling (Steink *et al.*, 1993; Lu and Lin, 1990),

tree productivity and mangrove related food chain (Ashton *et al.*, 1999). The present study aims to compare the rates of leaf litter degradation during dry and wet months as well as the leaf litter loss due to feeding plus mechanical breakdown by macro-organisms and microbial degradation.

MATERIALS AND METHODS

Description of the study area

The study area is 100 ha mangrove forest (3° 20' N Latitude and 101° 14' E Longitude) of Kuala Selangor Nature Park. This mangrove forest is totally protected since 1987 and categorized under Watson's (1928) tidal inundation class 4 characterized by tidal height ranges from 13 to 15 feet and inundated by water for 2 to 20 times per month. Species belonging to Avicenniaceae, Rhizophoraceae, Sonneratiaceae and Euphorbiaceae are found in this forest. *Bruguiera parviflora* is the dominant species that contributes about 80% of the growing stock.

Leaf litter degradation experiments

Bulk samples of yellowish freshly fallen leaves were collected from the litter layer. Collected leaf

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samples were sorted into three size classes as 10 to 15, 15 to 20 and 20 to 30 cm² respectively. Each sample contained a total of six leaves (two leaves from every class); the fresh, converted oven-dry weight and leaf area ranged from 2.79-4.38 g, 1.2-1.88 g and 100-128 cm² respectively. 110 sets of leaves in nylon bags and 110 sets of leaf on string were prepared and coded. For the estimation of leaf litter loss due to feeding plus mechanical breakdown each set of sample was sewn in monofilament nylon string through the lamina adjoining the mid-rib so that leaves did not overlap. However, for estimating microbial degradation each set of sample was placed in 300 x 150 mm nylon bag with 1 mm² mesh size. To prevent the leaves from folding and clumping they were laid flat and sewn and placed in the bag. One hundred litter bags and one hundred strings were placed in the field at the same time and ten bags and strings were brought back to the laboratory for calculating conversion factor for fresh to oven-dry weight at 105°C to constant weight. Bags and strings were tied with flagged pegs so that they remained flat on the sediment. Experiments were initiated during dry month (July) and wet month (November) in 2002. Field experiments that began in July 2002 were carried out four months but in November 2002 for one month. Ten bags and strings were collected at every five days interval for the initial month and subsequently at monthly interval for the remaining months. The collected leaf litter samples were gently washed and all sediments and dirt particles were then removed by using a soft brush with running tap water followed by final rinsing in distilled water. Each sample was then oven-dried at 105°C to constant weight and weighted. The loss in dry weight of the samples was calculated from the original converted oven-dry weight. The percentage of loss in initial dry mass in bags and strings was determined. The amount of leaf litter loss due to feeding plus mechanical breakdown was estimated based on the difference between mean dry weight loss of leaves on strings and mean dry weight loss of leaf litter in bags. The rate of degradation was calculated from the percentage of wet loss divided by respective days of collection. The different rates of litter degradation and leaf litter losses were transformed to arcsin and compared by one-way analysis of

variance (ANOVA) followed by Duncan's Multiple Range Test ($p < 0.05$) by using SAS (6.12). The rate of leaf litter degradation and loss due to feeding plus mechanical breakdown in different time periods of dry and wet months were compared by Hierarchical cluster analysis by using SPSS (11.0) statistical package.

RESULTS

Leaf litter loss and rate of degradation

The conversion equation and R² values of fresh weight to oven-dry weight and relationship between fresh weight and leaf area is presented in Table-1. Comparatively higher percentage of dry weight loss occurred in bags and strings during the wet month. In bags, 48% and 60% of the dry weight loss was observed for 120 and 30 days during dry and wet months respectively. All leaves on strings disappeared in 20 and 60 days respectively during wet and dry months (Fig. 1). Comparatively a higher rate of leaf litter degradation was observed during the wet month. Relatively a higher rate of leaf litter degradation in bags occurred in 10 and 5 days during dry months. In wet months, comparatively higher degradation rate was observed in 5 and 20 days (Fig. 2). Comparatively lower rate of leaf litter loss on strings was observed in 5 days and relatively higher rates was observed in 10 days during the initial

Table- 1: The conversion equation and R² values of fresh weight to oven-dry weight and relationship between fresh weight and leaf area

Variables	Equations	R ² values
Conversion of fresh weight to oven dry weight in July experiment	$y = 0.4747x - 0.0018$	0.98
Conversion of fresh weight to oven dry weight in November experiment	$y = 0.4541x - 0.0634$	0.98
Relationship between fresh weight of leaves and its area	$y = 27.255x + 7.5182$	0.93

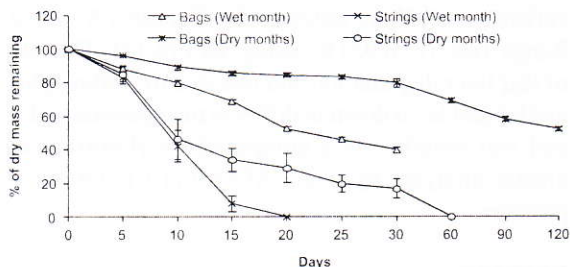


Fig. 1: Mean percentage of dry mass remaining at different time period during dry and wet months.

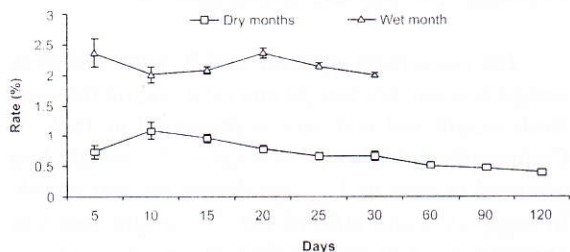


Fig. 2: Degradation rates of leaf litter in bags during dry and wet months.

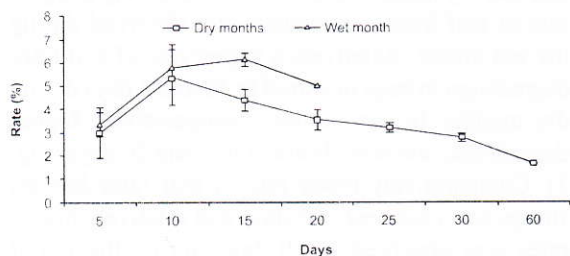
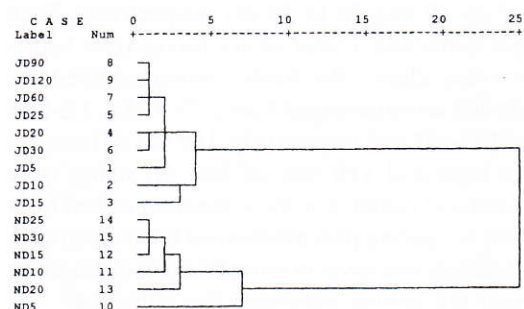


Fig. 3: Degradation rates of leaf litter on strings during dry and wet months.

period of dry and wet months (Fig. 3). The rates of microbial degradation in relation to days and seasons were compared and grouped into different clusters as Group 1: Having similar degradation rates at different collection periods during dry months and Group 2: Having similar degradation rates at different collection periods during wet months (Fig. 4). While, litter loss on strings were grouped into different clusters as Group 1: Having similar rates during 20, 25, 30, 60 days of dry months and 5 days of wet month, Group 2: Having similar rates during 10, 15, 20 days of wet month and 15 days of dry months (Fig. 5).

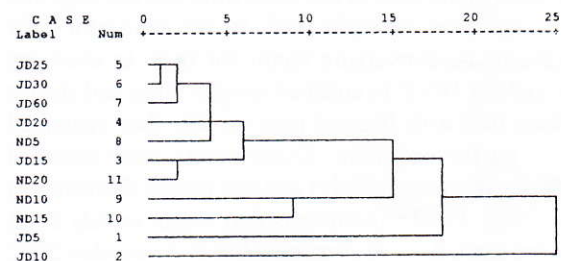
Rescaled distance Cluster Combine



JD5.....JD120 and ND5.....ND30 are different days of collection during July and November experiment.

Fig. 4: Rate of leaf litter degradation in bag experiment during dry and wet months.

Rescaled distance Cluster Combine



JD5.....JD60 and ND5.....ND20 are different days of collection during July and November experiment.

Fig. 5: Rate of leaf litter loss due to feeding plus mechanical breakdown during dry and wet months.

The contribution of macro-feeders and micro-organisms to leaf litter degradation

The contribution of macro-feeders and micro-organisms to leaf litter degradation is presented in Table-3. The percentage of dry weight loss due to feeding plus mechanical breakdown by crabs was relatively lower (11.31%-4.83%) for 5 days but comparatively similar (55.18%-52.61%) percentage of wet loss was observed for 20 days during the initial period of dry and wet months. Leaf litter grazed and mechanically broken down by crabs (*Sesarma versicolor*) amounted to 52.61% to 69.33% in wet and

dry months respectively, but the contribution of microbial degradation amounted to 47.39% and 30.67% (Table-3 and Fig. 1).

DISCUSSION

The rate of mangrove leaf litter degradation is highly species, sites and exposure conditions specific. Initial rapid loss of dry weight and higher rate of litter degradation was observed and it could be the result of rapid leaching of dissolved organic matter, including organic carbon, nitrogen and tannins (Robertson, 1988). Van der Valk and Attiwill (1984) reported 13% reduction in weight caused by leaching losses after 3 days when *Avicennia marina* leaf litter was submerged in seawater. Lu and Lin (1990) have shown higher rates of leaf litter degradation in *Avicennia*

marina and *Kandelia candel* during summer at Fujian, China but higher rates in *Rhizophora apiculata* was reported during heavy rainfall (Japar Sidik, 1989). Comparative results of leaf litter degradation with different mangrove species at various geographical locations is presented in Table-2. Different mangrove species and even same species showed different rates in relation to geographical locations and seasons. Present study shows that litter loss by feeding plus mechanical breakdown is not influenced by dry and wet months but microbial degradation is affected by seasons. Cundell *et al.* (1979) reported that readily leachable carbohydrate and tannins were lost from the submersed *Rhizophora mangle* leaf litter by 14 to 28 days as microbial population slowly grown on the leaf surface and started degradation of structural material. Japar Sidik (1989) studied the leaf litter

Table-2: Comparison of leaf litter loss and degradation rate with different mangrove species in different places

Geographical location and seasons	Species	Leaves litter loss		References
		Litter loss (%)	Days	
Kuala Selangor, Malaysia (Dry months)	<i>Bruguiera parviflora</i>			The present study
Litter bags		48	120	
Litter on strings (Wet months)		100	60	
Litter bags		60	30	
Litter on strings		100	20	Ashton <i>et al.</i> (1999)
Matang Mangrove forest, Malaysia (Wet months)				
Litter bags				
Cleared areas	<i>Bruguiera parviflora</i>	35	56	
Virgin Jungle Reserve		53	56	
Cleared areas	<i>Rhizophora apiculata</i>	50	56	
Virgin Jungle Reserve		58	56	
Cleared areas	<i>Rhizophora mucronata</i>	33	56	
Virgin Jungle Reserve		68	56	Tam <i>et al.</i> (1998)
Cleared areas	<i>Sonneratia alba</i>	85	56	
Virgin Jungle Reserve		93	56	
Shenzhen, China (Summer)	<i>Aegiceras corniculatum</i>	68	70	
Litter bags	<i>Kandelia candel</i>	88	42	Japar Sidik (1989)
Matang Mangrove forest, Malaysia	<i>Rhizophora apiculata</i>			
Litter on strings		94 to 98	180	
Litter bags		80	180	
Queensland, Australia (Summer)	<i>Rhizophora stylosa</i>	50	39	Robertson (1988)
Litter bags	<i>Avicennia marina</i>	50	10	
Matang Mangrove forest, Malaysia	<i>Ceriops tagal</i>	50	27	
Litter on string	<i>Rhizophora</i> spp	75 to 90	20	
	<i>Bruguiera</i> spp.	80	20	Ong <i>et al.</i> (1980)

degradation in *Rhizophora apiculata* at Matang Mangrove Forest Reserve, Malaysia. He reported that microbial degradation in 90 days was 22.8% to 58.6% in dry months and 26.9% to 76.7% in wet months. Loss due to feeding plus mechanical breakdown in 90 days was 12.6% to 49% and 7.3% to 29.8% for 90 days during dry and wet months respectively. According to Van der Valk and Attiwill (1984), 61% of *Avicennia marina* leaf litter was lost due to feeding plus mechanical breakdown at Westernport Bay Mangrove forest, Australia with 1.5 to 2.3 m tidal height during wet months. Leh and Sasekumar (1985) pointed out that food of five common species of Sesarminae crabs (*Chiromantes onychophorum*, *Chiromantes eumolpe*, *Clistocoeloma merguensis*, *Sesarma versicolor* and *Sesarmoides kraussi*) at Kapar Mangrove Forest Reserve, Malaysia consist of 83% to 97% mangrove plant matter.

CONCLUSION

Significant amount of nutrients is released into the mangrove ecosystems during the process of litter degradation. The released nutrients support tree productivity and food webs. Lower rates of litter decomposition may have implication for internal nutrient cycling and functioning of mangrove ecosystem. The rate of microbial leaf litter degradation

Table-3: The contribution of macro-feeders and micro-organisms to leaf litter degradation

Days	Mean percentage of wet loss on string	Mean percentage of wet loss in bags	Percentage of wet loss by feeding plus mechanical breakdown
Dry months			
5	15.02±5.48	3.72±0.57	11.31
10	53.53±11.85	10.92±1.41	42.61
15	65.69±6.82	14.38±1.02	51.31
20	70.76±8.91	15.58±1.11	55.18
25	80.03±5.34	16.69±1.08	63.34
30	82.99±5.69	20.17±2.47	62.82
60	100	30.67±1.41	69.33
Wet months			
5	16.7±2.6	11.87±1.16	4.83
10	57.96±9.46	20.1±1.32	37.86
15	91.98±4.45	31.2±0.9	60.78
20	100	47.39±1.61	52.61

is influenced by seasons but not the litter loss due to feeding plus mechanical breakdown by macro-feeders. Crabs not only grazed the freshly fallen leaves but also the aged leaves. Freely suspending leaf litter showed little evidence of sediment settlement and resuspension. Regional as well as local environmental factors and abundance of micro and macro-organisms influence the mangrove litter degradation. Thus, the rate of mangrove leaf litter degradation is highly species, site and exposure condition specific.

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ABUNDANCE OF COLLEMBOLANS AND MITES IN *ALBIZIA AMARA* BASED SILVOPASTURE IN BUNDELKHAND

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Abstract : Population build up of soil inhabiting collembolans and mites in *Albizia amara* based silvopastures was studied. Temporal distribution pattern showed peaks of population build up during August. Lower population build up was observed during March - June. The mites constituted about 82 per cent of the total population, the major group being cryptostigmata (61%) followed by prostigmata (13 %) and mesostigmata (8 %). A significant negative correlation existed between air temperature and population of cryptostigmata and prostigmata. The various groups of mite and the collembolan population were positively correlated with soil moisture.

INTRODUCTION

Among the various soil arthropod fauna, acarines and collembolans are the numerically dominant groups exhibiting a very high degree of diversity in species composition and feeding habits (Haq, 1984). Their density varies with the season, locality, microclimatic factors, etc. (Singh and Mukherjee, 1973; Prabhoo, 1976; Singh and Pillai, 1975).

Such organisms through their interaction with litter and microbes enhance the process of nutrient release by direct feeding litter and ameliorating spatial distribution and multiplication of soil micro biota (Anderson, 1975).

Although work in this area started getting importance during 1960s after the launch of International Biosphere Programme; the information on these lines in grasslands, forest lands and silvopastures (combining pasture grasses and trees) lacks in India, excepting some references pertaining to densities of oribatid mites in tropical and alluvial soils (Reddy, 1984 a; Vats, 1988).

Now a day, the silvopastures are being increasingly promoted on degraded lands for fodder, firewood and minor timber production besides the environmental gains in various parts of India. In Bundelkhand, *Albizia amara* based silvopasture has been identified as a promising land use (Pathak *et al.*,

1995). However, there is no information on aspects related to population dynamics of collembolans and mites in such systems. This study was, therefore, aimed to ascertain abundance of soil inhabiting collembolans and mites in such a system. The results obtained on aspects related to quantitative seasonal population built-up of soil inhabiting collembolans/mites, their relative abundance and correlation with selected microclimatic factors are being presented in this paper.

MATERIALS AND METHODS

Experimental Site

The study was accomplished at Jhansi (25°27'N latitude and 78°35'E longitude and about 275 m above mean sea level) during 1997 and 1998. The soil of the area was red with patches of red and black mixed soil. At places the soil had semi-rocky substratum. The texture of the soil was sandy clay loam to sandy clay. The soil was almost neutral with 38.6 per cent water holding capacity. Soil nutrient status was in low to medium range.

The system consisted of pasture stand + mature trees of *A. amara* (density about 440 trees/ha). The pasture stand consisted of five major perennial grass species, viz., *Cenchrus ciliaris*, *Chrysopogon fulvus*, *Dichanthium annulatum*, *Heteropogon contortus* and *Sehima nervosum*.

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