



Litter Fall Dynamics in Azhagar Hills of the Eastern Ghats, Tamilnadu, India

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Abstract

Litter production of tree species were studied in the six different sites in the Semi evergreen forest at Azhagar hills in the Eastern Ghats, Tamil Nadu India. Mean annual Litter fall in the study sites ranged from 29.86 to 46.32 g/m² year⁻¹. A greater amount of annual litter production was observed in the sites V and VI when compared to sites III, IV, II and I. This variation in Litter fall pattern among the sites could be attributed to species composition. Monthly variation in Litter fall pattern showed two peaks, one in the dry season (January-April) and another in (June - September). Contribution of leaf to the total litter was significantly (P<0.01) greater when compared to other components (twig, miscellaneous and fruit parts). On the basis of the species composition and disturbances, the six 0.1ha different study sites were selected. Sites I Foot hills and II Pazhamuthircholai were disturbed, sites III Silambar valley and IV Bison valley were moderately disturbed and sites V, Periaaruvi valley and VI Thalayanai parai were undisturbed sites. The dominant tree species in site I was *Benkara malabarica* followed by *Cassia excelsa*, *Wrightia tinctoria*, *Diospyros montana* and *Holoptelea integrifolia*, in site II *Benkara malabarica* followed by *Alangium salvifolium*, *Wrightia tinctoria* and *Holoptelea integrifolia*, in site III *Benkara malabarica* followed by *Commipora cordata*, *Wrightia tinctoria*, *Gyrocarpus americana*, *Alangium salvifolium*, *Strychnos-nux vomica* and *Lepisanthus tetraphylla*, in site IV *Ficus retusa* followed, by *Benkara malabarica*, *Alangium salvifolium*, *Strychnos-nux vomica*, *Haldenia cordifolia*, *Lepisanthus tetraphylla*, *Pleiospermium alatum*, *Holoptelea integrifolia*, in site V *Bekara malabarica* contributed more litter followed by *Ficus retusa*, *Wrightia tinctoria*, *Commipora cordata*, *Lapisanthus tetraphylla*, *Gyrocarpus americana*, *Mimusops elengi*, *Strychnos-nux vomica*, *Diospyros montana* and in site VI *Benkara malabarica* produced more litter followed by *Gyrocarpus americana*, *Commipora cordata*, *Wrightia tinctoria*, *Holoptelea integrifolia*, *Strychnos-nux-vomica*, *Alangium salvifolium*, *Strychnos potatorum*, *Menecylon heyneanum*, *Suregada angustifolia* and *Diospyros montana*.

Key words: Litter fall, semi evergreen forest, Eastern Ghats, Nutrient, Azhagar Hills.

Introduction

The study tries to find out the litter fall pattern in Semi evergreen forest of Eastern Ghats, semi evergreen ever green forests of Eastern Ghats, Azhagar hills in Madurai District, Tamilnadu. Also it tries to understand the intricacies of variations in Litter fall production of different forest sites, with it's effect on Ecology and the fertility of the soil. Disturbance is a prevalent factor in the Semi evergreen forest of Eastern Ghats and has led to believe that long term ecosystem dynamics of these forests are consequences of patterns of periodic disruptions. Factors like climate, season, canopy architecture, timing of canopy gap formation govern the dynamics of these ecosystem (Sukumar *et al.*, 1992; Benedetti and Bertoldi, 2000; Sandy Lia Dossantos *et al.*, 2002). Litter fall is a major functional part of any ecosystem as it plays a vital role in regulating nutrient cycling and

organic matter content. A substantial amount of organic matter returns to the forest floor through Litter fall. Leaves constitute about 70-90% of the total Litter fall in various forest ecosystems. It plays a significant role in transfer of energy to the major heterotrophs which inhabited in the forest soils. Litter fall, thus exerts a great influence on physical, chemical, and biological characteristics of soil. The maintenance of soil organic pool in semi evergreen ecosystem is achieved by the high and rapid circulation of nutrients through the fall and decomposition of litter (Ola-Adams and Egunjobi, 1992; Helmisaari, 1992a; 1995) The litter on the forest floor acts as an input-output system of nutrients (Das and Ramakrishnan, 1985) and the rates at which forest Litter falls and subsequently, decays regulate energy flows, primary productivity and nutrient cycling in forest ecosystems (Waring and Schlesinger, 1985). It is particularly important in



the nutrient budget of semi evergreen forest ecosystems on nutrient-poor soils, where vegetation depends on recycling of nutrients contained in the plant detritus (Singh, 1968). Bray and Gorham (1964) reviewed the rates of Litter fall in vegetation types throughout the world. Many reports suggested that density, basal area, age structure (Stohlgren, 1988), altitude (Reiners and Long, 1987), latitude (Bray and Gorham, 1964) and season are factors that strongly influence Litter fall dynamics in natural forest. However, Bray and Gorham (1964) in temperate forest ecosystem, and Kumar and Deepu, (1992) in semi evergreen forest ecosystem, reported that the Litter fall rates did not directly relate to stand basal area and density. Soil fertility, soil water retention and species composition are important within the same climate range (Facelli and Pickett, 1991). Although there have been several studies on litter dynamics in semi evergreen forest ecosystems in India (Rai and Proctor, 1986, Kumar and Deepu, 1992; Visalakshi, 1993; Khiewtam and Ramakrishnan, 1993; Tripathi and Singh, 1995; Francesca Cotrufo *et al.*, 2005), information on litter production and decomposition in natural forest ecosystem in the Eastern Ghats is limited. Therefore, in the present study an attempt was made to characterise the Litter fall dynamics of semi evergreen forest ecosystems at the Eastern Ghats of Tamil nadu to test weather Litter fall is a function of floristic composition, density, basal area and disturbance regime.

Study Area

The study area at Azhagar hills forest located away from 20km North-East of Madurai (78° 8' to 79° 2') is an feet elevation in the Madurai district of Tamilnadu, in South India. The mean annual rainfall recorded in the study sites was 1. The South west monsoon brings rainfall from September to November. From December to February rainfall is received from the North East monsoon. The monthly mean temperature lies between 25°C and 30°C. The maximum temperature goes up to 41°C during day time in the summer (April) and the night temperature was 29°C. In the cool season (December) the day temperature is 29°C and the night temperature was 17°C. More than 85% of the soil was red ferruginous type and 99.6% red loamy and sand and remaining 0.4% was black clay loam. Valley region alone were rich in humus. In sites I, II, III, V, VI *Benkara malabarica* was a dominant tree species and in site IV *Ficus retusa* was a

dominant tree species. The under story vegetation *Clausena dentata*, *Tarenna asiatica*, *Pavata indica*, *Glycosmis pentaphylla* and *Acalifa fruticosa* are common shrubs in all sites. Herbs species are *Ocimum canum*, *Blepharis madraspetensis* and *Sida acuta*, Monocotyledon species *Cynodon dactylon* is very dominant species in all study sites. *Acacia pinnata*, *Wattakaka volublis*, *Aristolochia indica*, *Cardiospermum halicacabum*, *Abrus precaterius*, *Asparagas racemosus*, *Deris trifoliata*, *Gymnema ealegans*, *hemidesmus indica*, *Ziziphus oenopilia* and *Dioscorea oppositifolia* are common lianas species in all study sites. Site I and II are subjected to more disturbances due to villagers, visitor impact, cattle and goat grazing fuel collection, encroachment, located to mining and quarrying area, in sites III and IV selective felling occur and minimum collection of plant products, sites V and VI are undisturbed, because two are sacred areas and minimum collection of medicinal plants.

Materials and Methods

Litter Collection

Twenty one 1m x 1m litter traps, 20cm high above the ground, were laid out at each site (Seven in each sub site). Litter was collected at monthly intervals from the traps for one year (2012) commencing in January 2003. The litter was taken to the laboratory and categorized into leaf, twig, miscellaneous and fruits. The leaf litter was then sorted out according to species. Dry weight of each component was determined by drying to a constant weight at 80°C and the mean monthly value for each sub site was worked out on a unit area basis g/m or t/ha. Occasionally a few traps were destroyed by animals and human in site I and II. In such cases, the mean values corresponding to the available traps per sub-site were used to determine the Litter fall. However, the damaged traps were subsequently replaced.

Result

Average annual Litter fall (2012) of the study sites ranged from 29.86 to 46.32 g/m² year⁻¹. Greater Litter fall was recorded in site V and VI compared to sites I, II, III and IV. Contribution of leaf litter to the total litter was greater when compared to other categories Twigs Litter fall, Miscellaneous and fruits. The total Litter fall was significantly variable of different collections intervals. In all the study sites, occurrence of Litter fall was greater during the dry season

(January-April) and it was also greater in the months of July to September (Rainy season). However, minimum Litter fall was recorded during June-July in site I and II. (Table – 1 & 2)

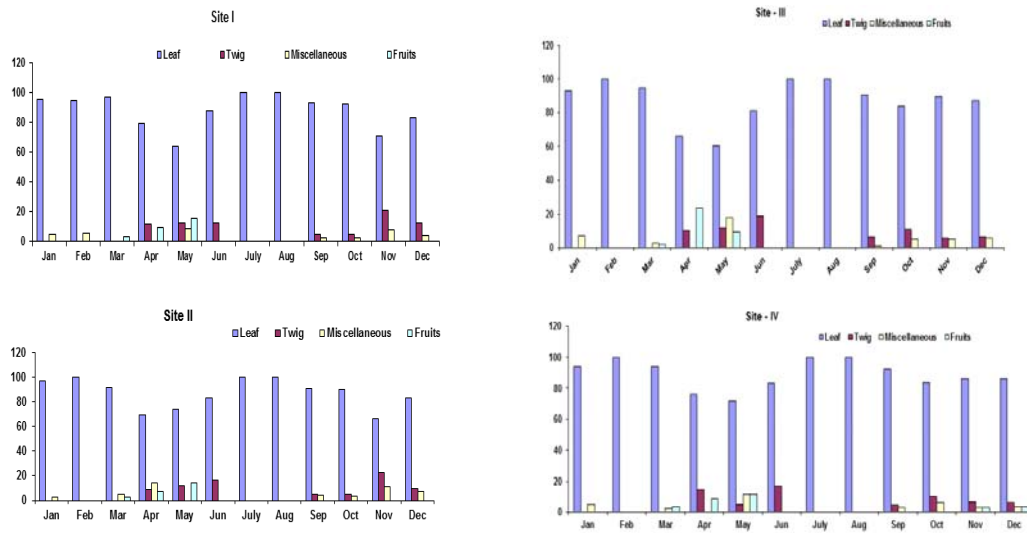
Table-1: Vegetation characteristics and litter production in six study sites at Azhagar hills forest in the Eastern Ghats of Tamil Nadu

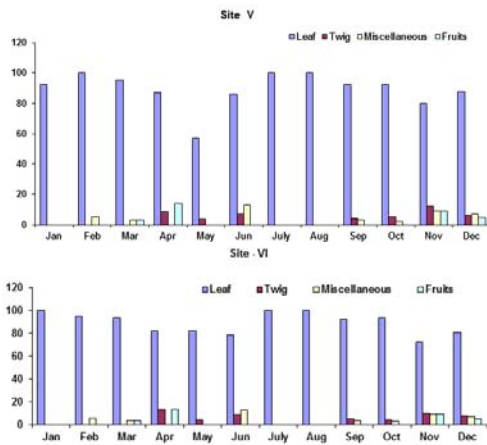
Categories	Site I	Site II	Site III	Site IV	Site V	Site VI	Significance level
Tree density 710cm GBH No/ha.	230	220	370	590	620	500	***c
Basel area (M ² ha ⁻¹)	6.59	8.57	14.38	46.38	48.49	44.31	***c
Annual litter fall(g/m ² year-1) 2003	31.51 ^a	29.86 ^b	42.33 ^b	42.48 ^b	46.32 ^b	45.02 ^b	** b
Standing crop of litter(g/m ²)mean Litter components(g/m ²)							
Leaf litter	28.41 ^a	26.8 ^b	38.17 ^a	38.68 ^a	41.61 ^a	40.65 ^a	***c
Twig	1.58 ^b	1.38 ^b	1.72 ^a	1.58 ^b	1.59 ^v	1.61 ^b	** b
Miscellaneous	1.06 ^b	1.06 ^b	1.57 ^a	1.31 ^a	1.77 ^a	1.58 ^a	** b
Fruits	0.46	0.43	0.88	0.91	1.35	1.18	***c

A Different Letter(s) on the same rows indicates significant difference bp<0.05, cp<0.01

Table - 2: Monthly total Litter fall (g/m²) of the Six study sites at Azhagar hillsforest in the Eastern Ghats of Tamil Nadu

Months	Site I	Site II	Site III	Site IV	Site V	Site VI
Jan	60.3	58.0	72.3	71.7	73.7	63.00
Feb	47.7	46.2	56.2	58.2	57.4	61.4
March	41.5	42.6	48.8	47.3	52.7	64.5
April	20.4	24.8	30.6	25.3	33.6	26.6
May	14.4	14.1	18.7	24.2	40.8	30.7
June	9.6	8.9	10.6	10.1	19.9	24.5
July	6.3	7.1	31.1	41.2	18.1	17.2
Aug	22.4	20.1	47.2	44.3	52.2	45.3
Sep	45.8	43.0	45.4	46.9	46.8	53.4
Oct	47.9	44.4	25.1	21.9	56.6	59.2
Nov	14.6	13.9	59.5	53.2	37.7	33.6
Dec	47.2	35.2	62.4	65.2	66.3	60.8





Percentage contribution of various litter components, such as leaf litter, twig, miscellaneous and fruits to the total monthly Litter fall of all the study sites are given in (fig. 1-6). The contribution of leaf litter to the total Litter fall was greater during the dry season. Leaf litter contribution was greater compared to other categories (Twig, Fruits, Miscellaneous parts) in all the study sites.

Annual nutrient concentrations of all the sites are presented in (Table - 3). Higher concentrations of nitrogen were recorded in undisturbed forest tree species followed by moderately disturbed forest tree species and disturbed forest tree species.

Discussion

Litter fall pattern in a rain-forest ecosystem (Hudds,1971), as in any other forest ecosystem type (Facelli and Pickett, 1991), is determined by a variety of factors, such as species composition, successional stage in its development and related microclimatic difference. Therefore, it is reasonable to expect variations in the litter fall pattern (Production) among the sites shown in the present study. The mean annual litter fall was greater in sites V and VI than that in sites III, IV, I and II. This variation in litter fall pattern among the sites could be attributed to species composition. Facelli and Pickett (1991) reported that the species compositions are important for litter production within the same climate range. In sites I and II *Albizia amara* contribute minimum amount of litter in addition to the common species. Similarly in sites III and IV *Albizia amara* and *Albizia lebbek* produced more litter fall and in site V and VI *Albizia amara* contributed most litter production in addition to common species. Therefore, the results suggest that species composition and their contribution towards litter becomes important in overall community or site-litter production, as observed in sites V and VI. Vogt et al (1985) also stated that the differences could be explained by tree behaviour, mean annual temperature, minimum monthly mean temperature, precipitation and latitude.

Table - 3: Annual input of Nitrogen, Phosphorus and Potassium (g/m²) by Litter fall of six study sites in Azhagar hills forest of Eastern Ghats of Tamil Nadu

Litter Component	Site I			Site II			Site III			Site IV			Site V			Site VI		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
Leaf	2.56 ± 0.01	0.31 ± 0.002	1.36 ± 0.01	2.35 ± 0.03	0.28 ± 0.02	1.03 ± 0.01	4.08 ± 0.04	0.55 ± 0.004	2.5 ± 0.02	4.18 ± 0.04	0.56 ± 0.004	2.57 ± 0.02	6.84 ± 0.06	0.80 ± 0.006	3.00 ± 0.026	6.39 ± 0.05	0.78 ± 0.006	2.93 ± 0.01
Twig	0.08 ± 0.007	0.02 ± 0.001	0.04 ± 0.003	0.06 ± 0.005	0.01 ± 0.009	0.04 ± 0.008	0.14 ± 0.001	0.01 ± 0.009	0.06 ± 0.005	0.13 ± 0.001	0.01 ± 0.009	0.06 ± 0.005	0.19 ± 0.002	0.02 ± 0.001	0.08 ± 0.007	0.20 ± 0.002	0.02 ± 0.001	0.08 ± 0.007
Miscellaneous	0.10 ± 0.009	0.03 ± 0.003	0.04 ± 0.003	0.11 ± 0.009	0.04 ± 0.003	0.04 ± 0.003	0.17 ± 0.001	0.014 ± 0.001	0.06 ± 0.005	0.15 ± 0.001	0.01 ± 0.009	0.06 ± 0.005	0.26 ± 0.002	0.06 ± 0.005	0.24 ± 0.002	0.23 ± 0.002	0.06 ± 0.005	0.20 ± 0.002
Fruits	0.02 ± 0.001	0.02 ± 0.001	0.07 ± 0.008	0.02 ± 0.001	0.01 ± 0.009	0.07 ± 0.006	0.05 ± 0.004	0.04 ± 0.003	0.15 ± 0.001	0.05 ± 0.004	0.04 ± 0.003	0.15 ± 0.001	0.19 ± 0.002	0.06 ± 0.005	0.23 ± 0.002	0.17 ± 0.001	0.06 ± 0.005	0.20 ± 0.002
Total	2.76 ± 0.02	0.38 ± 0.003	1.51 ± 0.01	2.54 ± 0.02	0.34 ± 0.003	1.18 ± 0.01	4.44 ± 0.04	0.61 ± 0.005	2.77 ± 0.02	4.51 ± 0.04	0.62 ± 0.005	2.64 ± 0.02	7.48 ± 0.06	0.94 ± 0.008	3.55 ± 0.03	6.99 ± 0.06	0.92 ± 0.008	3.41 ± 0.03

Average ± S.D

The mean annual litter fall at six study sites of the present study did not appear to be directly related to basal area and density Differences in tree basal area ranged between 6.59 to 48.49

m²/ha. However, these differences failed to manifest it in terms of litter fall rates. Past studies also failed to establish cause-effect relationships between such parameters and litter fall in



temperate forests (Bray and Gorham, 1964) and tropical forests (Kumar and Deepu, 1992). In contrast, Stohlgren (1988) suggested that annual litter fall can be better predicted by a function derived from the individual tree basal area and live crown ratio. In the present study, month to month variation in litter production was recorded. Other studies (Songuwe *et al.*, 1988; Lisanework and Michelsen, 1994) also should considerable variation in litter production between the years. The outcome of the present study suggests that further scientific research is to be oriented towards understanding the intricacies of variations in Litter fall production between different forest sites.

The mean annual Litter fall in the present study (3.58-5.56 mg ha⁻¹ year⁻¹) is comparable with the values reported by others. The values obtained in the present study lie among the lower limits of the values (5.05 – 15.03 mg ha⁻¹ year⁻¹) reported by William and Gray (1974) in equatorial forests 13.51 and 13.27 t ha⁻¹ Yr⁻¹ Arul Pragasan *et al.*, (2005) and (2.906 to 7.847 Mg ha⁻¹ Year⁻¹) reported by Cutini (2002) in the Conecofor perucement Monitoring plots. The values is also lower than those reported from elsewhere (Bray and Gorham, 1964; Songuwe *et al.*, 1988; Scott *et al.*, 1992; Lisanework and Michelsen, 1994) and India (Gupta and Rout, 1992, Kumar and Deepu, 1992; Khiewtam and Ramakrishnan, 1993; Visalakshi, 1993; Sundarapandian and Swamy, 1999).

Periodicity of Litter fall is largely followed by annual cycles of environmental parameters. Our study showed that one major peak of Litter fall occurred during the dry season (January -April) and a smaller peak in (July to September). The significant season variation in litter production with highest values in the dry months is in agreement with the results of other authors (Hopkins, 1966; Kumar and Deepu, 1992, Muoghalu *et al.*, 1993). Available studies concerning deciduous plantations clearly showed that the deciduous species yielded maximum litter during the summer period (Kikuzawal *et al.*, 1984). Pascal (1988) reported that the rhythm of leaf shed was characterised by a heavy Litter fall during the dry season in wet evergreen forests of Aattappadi, Western Ghats, India. Jackson (1978) assumed that in environments where the temperature variation throughout the year is small and moisture availability is seasonal, dry season leaf fall and wet flushing will occur to avoid seasonal moisture stress. Moore (1980)

reported that water stress triggers de novo synthesis of abssic acid in the foliage of plants which, in turn, can stimulate senescence of leaves and other parts. The second peak of Litter fall during July to September (rainy season) could be attributed to strong winds as well as heavy rain, as is reported in the forests of Sarawak (Proctor *et al.*, 1983) and Nigerian rain forests (Muoghalu *et al.*, 1993). Leaf litter constituted a substantial portion of the total litter production in the present study, with the results of others (Morellato, 1992, Scott *et al.*, 1992; Khiewtam and Ramakrishnan, 1993; Muoghalu *et al.*, 1993; Visalakshi, 1993; Stocker *et al.*, 1995).

Nutrient composition of the litter was regarded as a measure of the intrinsic quality (decomposability) and environmental characteristics of the soil and climate which in turn affect the release of the important nutrient elements through decomposition. Nutrient concentrations of litter under various forests emphasized that concentrations of nitrogen was highest followed by potassium and phosphorus. Generally, the leaf, miscellaneous part and fruit litter compartments registered higher concentration of nutrients. Phosphorus content was more in reproductive components of litter in all the forest types as observed by Singh *et al.*, (1993). Twig litter made the lowest concentration of nutrients. Similar results in nutrient concentrations in the litter were reported by many other workers (George, 1982; George and Varghese, 1990; Kumar and Deepu, 1992; Singh *et al.*, 1993).

The winter and summer seasons (December - April) were well characterized by the higher concentrations of litter nutrients and the rainy seasons (June – September) were characterized by low content of nutrients, (Khiewtan and Ramakrishnan, 1993) also reported uniformly low values for N, P and K of litter samples during the wet season. This may be due to increase in leaching of such nutrients during that season (Das and Ramakrishnan, 1985)

The data pertaining to nutrients returns in various forests through litter fall was presented. In all the six sites, maximum return of nutrients was through leaf litter. Among the various nutrients maximum return in all the six sites was for nitrogen followed by potassium and phosphorus. Similar kinds of results were reported for different plantations and forests in Uttar Pradesh (George, 1986) and Karnataka (Sugar, 1989;



Hosur *et al.*, 1997). Generally, site V and site VI registered highest return of N, P and K among the six forests which may be due to higher litter fall.

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