Res. J. Pl. Environ. 2 (2) : 63–70, 1985

SEASONAL FLUCTUATION IN THE FLOOR COMPONENT BIOMASS UNDER MOIST TEMPERATE HIMALAYAN FOREST

K. S. NEGI, ARUN K. AGRAWAL and J. S. SINGH*

Department of Botany
Government Post Graduate College, Kotdwara (Garhwal) 246 149

ABSTRACT

The year long mean litter biomass ranged between 1129.0 and 1241.0 g m^{-2} on the three *Quercus* species dominated sites. The total quantity of the forest floor also varied from month to month. The lower slope had twice or thrice as much floor biomass as the upper slope.

INTRODUCTION

The organic matter present on the forest floor plays a major role in determining ecosystem structure, function and represents an energy source for heterotrophic organisms, a nutrient reservoir for intrasystem cycling and regulating factor influencing forest hydrology (Ashton and Macauley, 1972; Ashton, 1975). The forest floor categorised into litter (top most), duff (middle) and humus (bottom) by Fernow (1917). Ashton (1975) described the litter layers as more or less equally stratified 'L' layer of the freshly fallen leaves, bark and twigs and 'F' layer or decaying layer of the fragmented leaves supported by a meshwork of more resistant twigs, wood and bark. The 'H' or humified layer was found to be intimately mixed with kasmozemic top soil to the depth of about 30–35 cm. Various workers estimated litter accumulation (Singh, 1962; Woodwell and Marples, 1968; Monk *et al.*, 1970; Rieners and Reiners, 1975) and yearly fluctuation in the amount of litter deposited (Brey and Gorham, 1964; Pandey, *et al.*, 1968) in the various parts of the world.

In most forests the ground vegetation contributes only a small share to the total biomass of the ecosystem (Ovington, 1965; Whittaker, 1966). Nevertheless, the ground vegetation forms an important structural component of forest ecosystem. During the early successional changes or in young plantations, the biomass of ground vegetation

* *Present Address :* Reader, Department of Botany, University of Kumaon, Nainital, U. P.

may be equal to or even higher than the ligneous biomass (Satoo, 1967). The present study quantified the forest floor components in time series mode.

MATERIAL AND METHODS

The sites were at an elevation of 1800–2000 m msl in the Thalkedar forest (29°30' N lat. and 80°15' E long.), bounded by rivers Kali and Ramganga, respectively, on East–South direction and West direction and by Pithoragarh town in the North. No climatic data are available for the site so the data for nearby Champawat Meterological Department (elevation 2000 m msl) were used. This site has a mean annual temperature of 6.5 °C, a January mean of −2.5°C and a July mean of 18.6°C. The mean annual precipitation is 1656.6 mm, 45% of which falls as snow. About three fourth area of Thalkedar is covered with dense evergreen forest. The vegetation of the site was dominated with *Quercus* species in association with *Rhododendron arboreum*, *Lyonia ovalifolia* and others with an understorey of *Vibernum cotonifolium*, *Rosa moschata* and *Rubus* species.

The data were collected by using 50 X 50 cm sampling plots. A total of 5 quadrats were sampled in each sampling date (first week of each month from January, 1979 to December, 1979) from each of the two slope positions (upper hillock and lower slope). The present study was conducted randomly. From each quadrat, first the live herbaceous vegetation was harvested at ground level. Then, freshly fallen leaf litter and twigs were collected. Subsequently, the miscellaneous litter (standing dead shoots of herbs, unaltered twigs, flowers, fruits and other unidentified intact organic material), partly decomposed litter (fragmented leaf litter and partially decomposed twigs) and more decomposed litter (finally fragmented leaf litter and other organic debris, often unrecognized) were collected in the same order. The total material in each category collected from each quadrat was weighed in the field by using spring balance (accuracy, 1 g). A 100 g sample for each category was packed in polythene bags, brought to the laboratory, oven dried at 80 °C and weighed. The data are expressed as g dry weight per m^2. Site II represents the transitional zone of site I and III, so detailed data of this site only presented in the observation to compare with the rest two sites.

The turn over rate of litter was calculated by the following equation (Jenney *et al.*, 1949; Koelling and Kucera, 1965) :

$$K = \frac{A}{A + Fe}$$

where, K = Turn over rate, A = Annual litter fall, Fe = Minimum amount of litter on the forest floor with in the year.

OBSERVATIONS

The year long variation in the biomass of the different forest floor compartments on upper and lower slope of site II are given in figure and monthly biomass with per cent contribution is given in Table–I.

On the upper slope, the growth of live herbaceous vegetation (LHV) began in the month of March – April and reached maximum value in September – October. Therefore, the biomass declined rather rapidly and assumed a zero value in February. On the other hand, because of more perennial components the live herbaceous vegetation was present throughout the year on the lower slope. On an average, the biomass of LHV was lowest in February (24.2 g m^{-2}) and highest in October (318.0 g m^{-2}). Subsequently, the biomass declined. The per cent contribution values of ground vegetation to the forest floor ranged from 2.6% (February) to 18.7% (November).

The biomass of miscellaneous litter (ML) varied throughout the year on both the slopes. However, the average biomass was found maximum in November (128.2 g m^{-2}) and minimum in July (47.9 g m^{-2}). Most of the ML in November–December resulted from the conversion of live herbaceous vegetation into the standing dead component. The per cent contribution to the total floor by ML ranged between 3.8% (August) and 9.8% (December). Average year long mean indicated that the amount of ML was greater on lower slope (100.6 g m^{-2} yr^{-1}) as compared to the upper slope (46.7 g m^{-2} yr^{-1}).

Fresh leaf litter (FLL) biomass gradually increased from January – February and it was found maximum in the month of June (291.8 g m^{-2}), subsequently, the biomass declined from June and the minimum value was recorded in October (51.3 g m^{-2}). Slope position also exhibited marked differences in the accumulation of FLL. The year long mean biomass was found greater on the lower slope (243.7 g m^{-2}) compared to the upper slope. The per cent contribution to the total forest floor biomass by this category accounted for 2.8% (October) to 29.6% (April).

Reverse to the FLL trend was observed in partially decomposed litter (PDL) and in more decomposed litter (MDL). These categories exhibited maximum value in October – November and minimum in the April–May, respectively. There were marked fluctuation in the biomass of PDL and MDL categories on the slope position. The year long-mean indicated that the biomass of these categories were higher on lower slope as compared to the upper slope.

Analysis of variance showed that the difference in the biomass of LHV, ML and FLL due to months and slope position were statistically significant, while PDL and MDL were significant only among the slope and were insignificant due to the month.

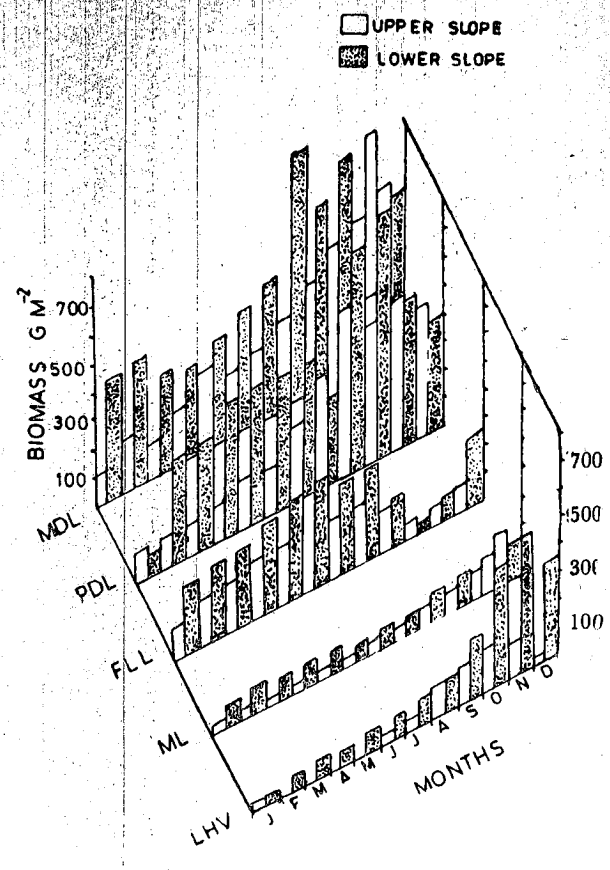

Fig.-1. Monthly variation in the biomass of forest floor categories under temperate forest community. LHV = Live herbaceous vegetation, ML = Miscellaneous litter, FLL = Fresh leaf litter, PDL = Partially decomposed litter, MDL = More decomposed litter.

TABLE–I

Average biomass of the forest floor (g m^{-2}) on site–II. Values in parentheses represent per cent contribution to the total biomass.

Month	Forest floor categories					
	Live herbaceous vegetation	Miscellaneous litter	Fresh leaf litter	Partially decomposed litter	More decomposed litter	Total
January	25.8 (2.8)	60.4 (6.6)	179.2 (19.8)	342.4 (37.7)	300.0 (33.1)	908.5
February	24.2 (2.6)	60.4 (6.4)	200.9 (21.2)	316.4 (33.4)	344.5 (36.4)	946.4
March	29.9 (3.4)	68.0 (7.7)	214.0 (24.4)	331.2 (37.7)	335.0 (26.8)	878.0
April	26.9 (3.0)	61.4 (6.7)	269.4 (29.6)	258.0 (28.4)	293.6 (32.3)	909.4
May	49.5 (3.9)	60.6 (4.8)	278.6 (22.0)	500.1 (39.6)	377.6 (29.8)	1266.4
June	53.8 (4.7)	61.9 (5.4)	291.8 (25.3)	350.4 (30.4)	395.1 (34.3)	1153.0
July	66.6 (5.5)	47.9 (3.9)	261.3 (21.4)	414.0 (33.9)	430.5 (35.3)	1220.4
August	106.0 (7.4)	55.7 (3.8)	260.1 (18.2)	480.8 (33.6)	528.0 (36.9)	1430.6
September	170.0 (11.4)	70.5 (4.6)	159.8 (10.5)	570.5 (37.4)	555.0 (36.4)	1225.8
October	318.0 (17.1)	89.6 (4.8)	51.3 (2.8)	707.6 (38.1)	688.0 (37.1)	1854.6
November	297.9 (18.7)	128.2 (8.0)	68.5 (4.3)	414.6 (26.0)	687.2 (43.1)	1596.3
December	194.6 (15.9)	119.6 (9.8)	168.6 (13.8)	282.0 (23.0)	457.6 (37.4)	1222.4
Year long Mean	113.6	200.3	73.7	414.0	441.0	1242.6

TABLE–II

Year long mean biomass of different floor components on the three sites (g m^{-2})

Forest floor categories	*Quercus incana* *Rhododendron arboreum*	*Quercus dilatata* *Quercus incana*	*Quercus languinosa* *Rhododendron arboreum*	Average of all sites
	SITE–I	SITE–II	SITE–III	
Live herbaceous vegetation	138.4	113.6	110.0	120.7
Miscellaneous litter	128.6	73.7	67.5	89.9
Fresh leaf litter	215.9	200.3	173.5	196.6
Partially decomposed litter	405.4	414.0	395.2	404.9
More decomposed litter	491.1	441.0	414.7	448.9
Total	1379.4	1242.6	1160.9	1261.0

TABLE–III

Mean monthly total biomass of forest floor on the two slope positions across the three sites (g m^{-2})

Month	Upper slope	Lower slope	Average
January	388.4	1306.8	847.6
February	378.2	1370.8	874.5
March	763.9	1303.1	1033.5
April	600.5	1301.4	950.9
May	742.2	1500.9	1121.5
June	816.3	1587.2	1201.7
July	862.3	1640.3	1251.3
August	1067.3	1877.3	1472.3
September	1163.8	1927.5	1545.6
October	1313.3	2322.5	1818.9
November	1257.1	2287.0	1772.0
December	779.2	1743.9	1261.5
Average	814.1	1653.1	1233.6

DISCUSSION

The quantity of forest floor depends upon the canopy closure altitude and climate. The *Quercus incana*, *Q. dilatata* community (site–II) had a mean forest floor biomass (1242.6 g m^{-2}) lower than that of *Quercus incana* – *Rhododendron arboreum* community (site–I; 1379.4 g m^{-2}) but higher than that of the *Quercus languginosa – Rhododendron arboreum* community (site–III; 1160.9 g m^{-2}) (Table–II). Site–I located at the lower altitude while site–III represented the highest altitudinal range in the present study. The grand averages across sites indicate that the minimum quantity of forest floor biomass occurred in January and the maximum in October. Thus, the forest developed maximum floor biomass during the later part of the rainy season or in early part of the winter. The period of higher floor biomass usually corresponded with the peak biomass of herbaceous vegetation (attained in October) and the greatest accumulation of PDL and MDL in October and December (Negi, 1980).

The present study also indicated that the lower slope had twice or thrice as much floor biomass as the upper slope (Table–III). Thus while the upper slope (average across the sites) had the floor biomass in the range of 378.2 to 1313.3 g m^{-2}, the total biomass on the lower slope varied between 1301.4 to 2324.5 g m^{-2}. The higher floor biomass on the lower slope was probably due to (i) greater development of herbaceous vegetation and (ii) the collection of litter from the upper slope due to wind and rain action.

Among the categories, the forest floor was dominated by the more decomposed litter on all the sites. This category accounted for 35.5 to 35.7% of total forest floor biomass on the three sites. The next important category in this respect was the partially decomposed litter which accounted for 29.4 to 34.4% of the total forest floor biomass. Together, the above two categories were responsible for 67.2% of total forest floor biomass. The accumulation of categories of litter is the indicative of lower decomposition rate because of low temperature.

There are comparatively few reports on the biomass of herbaceous vegetation in woodland ecosystems. Killingbuck Wali (1978) estimated total above ground herbaceous biomass in North Dakota Gallery forest at 70.0 to 74.4 g m^{-2}. A herb stratum biomass 220.0 g m^{-2} was estimated for an oak forest in Belgium by Duvigneaud and Denaeyer de Smet (1970). In the present study, the year long mean herbaceous biomass ranged between 110.0 to 138.4 g m^{-2} on all the three sites. These values are thus within the range of reported other temperate forests. A number of workers have estimated the amount of litter on the forest floor under different forest types. For an oak-pine forest of long Island, Woodwell and Marples (1968) have estimated 1595 g m^{-2} litter (excluding humus). Reiners and Reiners (1970) reported 12060 g m^{-2} litter in 'L' and 'F' layer under an oak forest of Minnesota, while Monk *et al.*, (1970) estimated 956 g m^{-2} litter for an oak – Hickery forest in Georgia. In mixed oak forest, Lang (1974) found 872 g m^{-2} litter which included 'L' and 'F' layer, L + F woody tissue and fruit parts. Ovington (1959) found that the weight of surface litter varied from 370 to 3480 g m^{-2} under 50 years old forest stand in England. Singh and Misra (1978) reported year long mean litter biomass of 363.4 and 398.7 g m^{-2} under two natural stands of deciduous forest at Varanasi. The present estimates ranged between 1129.0 and 1241.0 g m^{-2} on the three sites which are towards the upper range of values reported for the temperate forest.

The litter fall was estimated on site–II. Total input of organic matter through litter fall was 689.62 g m^{-2} yr^{-1} (Negi, 1980). The input of organic matter through herbaceous vegetation was calculated by the following equation :-

Herbaceous Litter Input = (ANP + Live biomass in the beginning) — biomass at the end of the year, where ANP represented the difference between the maximum biomass of live herbs and the preceding minimum biomass.

This calculation resulted in an estimate of 125.0 g m^{-2} yr^{-1}. Thus, the total annual litter input to the forest floor amounted to 814.2 g m^{-2}

The results of turn over rate for the litter only yielded a value of 0.45 and for litter including litter input through herbaceous vegetation, 0.49. These rates indicate a turn over time (1/K) between 2.0 to 2.3 years, and are comparable to the values for a majority of temperate forests, though slightly towards the upper range (Singh and Gupta, 1977).

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