ABSTRACT

A study of the leaf litter decomposition rates and contribution of the soil microarthropods to the leaf litter decomposition process at two elevational plots which have varied microclimatic in the Phayeng protected sub-tropical forest ecosystem, Manipur was carried out. Mass losses from litterbags and colonization of microarthropods in the decomposing leaf litter of four dominant species, viz., Quercus serrata, Lithocarpus dealbata, Castanea sativa and Schima wallichii were studied in different months and seasons. The altitudes of the Phayeng protected sub-tropical forest ecosystem ranges from 880 m to 1765 m above Mean Sea Level (MSL). The study area has a monsoon type, rainforest climate. The total annual rainfall recorded during the study period was 143.05 mm. Most of the rainfall occurred during the period from May to October. The mean minimum and maximum temperatures recorded during the study period were 8.5° C (January) and 28° C (July) respectively.

Litterfall estimations were carried out in each of the experimental plots by the quadrat method. A wooden quadrat of size 50 × 50 cm² was laid permanently in the forest plots. Litter was collected from each quadrat every month. The litter samples were gently hand picked into polyethene bags, labeled and packed.
The litter bag technique (Crossley and Hoglund, 1962) was used to monitor the mass loss of leaf litter of the four litter types and also to assess microarthropods population at both the plots. Freshly fallen leaves of *Q. serrata, L. dealbata, C. sativa* and *S. wallichii* were gathered from the forest floor of the two plots during the peak period of litterfall in January 2004. These leaves were air-dried, weighed 10 g each and placed in \(10 \times 10\) cm nylon bags (2 mm mesh size) and placed on the soil surface of the study areas. Three litterbags per species were collected from each plot at monthly interval. Litter from litterbags were removed and washed by tape water in the laboratory and oven dried to a constant weight to determine the remaining mass of leaf litter.

Decay constants were determined for the different litter types using an exponential decay model (Boulton & Boon, 1991), \(m_t = m_0e^{-kt}\) where \(m_t\) is mass remaining at time \(t\); \(m_0\) is the initial mass and \(k\) is the decay constant also known as the breakdown rate constant.

Microarthropods were extracted by placing the litterbags in modified Tullgren funnel for 6 to 7 days and preserved in 75% ethanol with 3 to 4 drops of glycerol. They were sorted out, counted and identified using a binocular microscope and the samples were identified at the Zoological Survey of India (ZSI), Kolkata.

The physico-chemical factors of the soil and litter such as moisture contents, temperature, pH, nitrogen, phosphorus, lignin and cellulose were determined during each sampling period to investigate the impact of these factors on the decomposition rate and
population densities of soil microarthropods. Soil temperature was recorded with the help of a thermometer by inserting a few centimetre inside the soil and litter layer. Soil and litter moistures were determined by gravimetric method after oven-drying the samples at 105°C to constant weight. The soil and litter nitrogen and phosphorus were analysed by FAI STAR 5000. Litter lignin and cellulose contents were analysed by using the Fibertec system M1017 Hot Extractor.

The mean mass losses (the average of three samples in the twelve months decomposition) of the four litter types (Q. serrata, L. albata, C. sativa and S. wallichii) at the two elevational plots were determined. The leaf litter decomposition appears to follow an exponential decay pattern for all the litter types at both Plots. It is observed that the mean mass losses at Plot II (lower elevation) were higher than those of Plot I (higher elevation). Leaf litter mass losses for the four litter types were measured for twelve months at the two elevational Plots. The decomposition proceeded slowly during the initial two months with mean mass losses of 5.30%, 2.70%, 6.50% and 8.90% respectively for Q. serrata, L. alberta, C. sativa and S. wallichii respectively at Plot I. The mean mass losses during this period at Plot II were respectively 6.30%, 5.80%, 7.60% and 8.20% for the four litter types. The mean mass losses after the end of 12 months at both Plots were observed to be highest for C. sativa (70.50% at Plot I and 73.10% at Plot II) and least for S. wallichii (60.60% at Plot I and 62.20% at Plot II). An important factor responsible for the highest mean mass losses in the case of C. sativa may be due to the highest initial contents of nitrogen (1.90%) and phosphorus (0.72%) and the least initial content of lignin (18.82%) among the four litter
types. On the other hand, the initial contents of nitrogen were the least in the case of *S. wallichii* (0.78% and 0.49% respectively) and the initial lignin content is the highest (34.27%) compared with the other three litter types. As a result, the mean mass loss for *S. wallichii* is the least among the four litter types. The mean mass loss is positively and significantly correlated with initial contents of nitrogen ($r^2 = 0.86$ for Plot I and $r^2 = 0.99$ for Plot II); phosphorus ($r^2 = 0.97$ for Plot I and $r^2 = 0.95$ for Plot II) and cellulose ($r^2 = 0.74$ for Plot I and $r^2 = 0.95$ for Plot II). However, the mean mass loss is negatively and significantly correlated with the initial lignin content ($r^2 = -0.80$ for Plot I and $r^2 = -0.99$ for Plot II). The two factor Analysis of Variance (ANOVA) of the decay constants of the four litter types at the two Plots showed that the annual decay constants were not significantly different between the two plots whereas there existed significant differences in the annual decay constants between the litter types ($P < 0.05$). The rates of leaf litter decomposition for the four litter types at both Plots exhibits similar trends with the peak values during the rainy season and minima during the winter season.

The influence of various abiotic factors e. g. rainfall, temperature and moisture were studied. The rates of leaf litter decomposition were positively and significantly correlated with rainfall ($r^2 = 0.84$ (P < 0.001) for *Q. serrata*, $r^2 = 0.69$ (P < 0.05) for *L. dealbata*, $r^2 = 0.89$ (P < 0.001) for *C. sativa* and $r^2 = 0.72$ (P < 0.01) for *S. wallichii* at Plot I); litter moisture ($r^2 = 0.90$ (P < 0.001) for *Q. serrata*, $r^2 = 0.79$ (P < 0.005) for *L. dealbata*, $r^2 = 0.93$ (P < 0.001) for *C. sativa* and $r^2 = 0.67$ (P < 0.05) for *S. wallichii* at Plot I) and soil moisture ($r^2 = 0.90$ (P < 0.001) for *Q. serrata*, $r^2 = 0.62$ (P < 0.05) for *L. dealbata*, $r^2 = 0.88$
(P < 0.001) for C. sativa and $r^2 = 0.50$ (P > 0.05) for S. wallichii at Plot I). However, the correlations between the rates of decomposition and the soil and the litter temperatures were observed to be rather weak.

The number of microarthropods and rainfall are positively and significantly correlated at both Plots. At Plot I, $r^2 = 0.76$ (P < 0.005) for Q. serrata, $r^2 = 0.73$ (P < 0.01) for L. dealbata, $r^2 = 0.71$ (P < 0.05) for C. sativa and $r^2 = 0.68$ (P < 0.05) for S. wallichii. The number of microarthropods are also significantly and positively correlated with soil temperature ($r^2 = 0.61$ (P < 0.05) for Q. serrata, $r^2 = 0.64$ (P < 0.05) for L. dealbata, $r^2 = 0.66$ (P < 0.05) for C. sativa and $r^2 = 0.64$ (P < 0.05) for S. wallichii at Plot I); soil moisture ($r^2 = 0.81$ (P < 0.005) for Q. serrata, $r^2 = 0.78$ (P < 0.005) for L. dealbata, $r^2 = 0.77$ (P < 0.005) for C. sativa and $r^2 = 0.76$ (P < 0.005) for S. wallichii at Plot I); litter temperature ($r^2 = 0.73$ (P < 0.01) for Q. serrata, $r^2 = 0.76$ (P < 0.01) for L. dealbata, $r^2 = 0.77$ (P < 0.01) for C. sativa and $r^2 = 0.74$ (P < 0.01) for S. wallichii at Plot I); and litter moisture ($r^2 = 0.94$ (P < 0.001) for Q. serrata, $r^2 = 0.92$ (P < 0.001) for L. dealbata, $r^2 = 0.89$ (P < 0.001) for C. sativa and $r^2 = 0.89$ (P < 0.001) for S. wallichii at Plot I).

The densities of collembo and acarina at Plot I and II are 18753 m$^{-2}$ and 21491 m$^{-2}$ respectively. At Plot I the Shannon Wiener’s diversity indices for collembo and acarina in the leaf litters of Q. serrata, L. dealbata, C. sativa and S. wallichii are 3.151, 3.145, 3.172 and 3.191 respectively and at Plot II these indices are 3.177, 3.182, 3.180 and 3.157 respectively. The number of microarthropods and the rates of decomposition are positively
and significantly correlated. At Plot I, $r^2 = 0.87$ (P < 0.001) for Q. serrata, $r^2 = 0.67$ (P < 0.05) for L. dealbata, $r^2 = 0.84$ (P < 0.001) for C. sativa and $r^2 = 0.59$ (P < 0.05) for S. wallichii. Among the microarthropods, acarina is better correlated with the rate of decomposition as compared to that of collembola. It can be due to the higher number of acarina present in the leaf litter. In each of the Plots I and II the number of microarthropods is minimum in the leaf litter of S. wallichii and it is maximum in the leaf litter of C. sativa. Correspondingly, leaf litter decomposition is minimum for S. wallichii and maximum for C. sativa at both Plots. Population variation of the microarthropods through time followed a seasonal pattern which was remarkably similar for both Plots and litter types. Microarthropods population was found to be higher during the rainy season and minimum during the winter season synchronizing with the decomposition rate. The increase in the number of microarthropods and the rates of leaf litter decomposition during the rainy season coincides with the timing of canopy closure, temperature raise and maximum rainfall. The canopy protects the forest from direct sunlight and rapid desiccation and this condition is more significant in the case of Plot II. A deep litter layer which remains intact for a longer period under high relative humidity is developed at Plot II resulting in a higher number of microarthropods and higher rates of leaf litter decomposition. The lower population in the number of microarthropods during the winter season may be due to low rainfall, low temperature and dry conditions of the litter and soil which are unfavourable for the microarthropods. Thus, microarthropods play an important role in the leaf litter decomposition process which is also mediated by various abiotic factors and the nutrient quality of the litter.
List of Publications

- Leaf Litter Decomposition, Abiotic Factors and Population of Microarthropods in a Sub-tropical Forest Ecosystem, Manipur, North East India.
  Kh. Sunanda Devi and Th. Binoy Singh,

Papers presented in Seminars / Conferences

- Contribution of Microarthropods on leaf litter decomposition of three dominant tree species in the Phayeng Sub-tropical Forest Ecosystem, Manipur.
  Kh. Sunanda Devi and Th. Binoy Singh

- Seasonal Community Structure of Microarthropods and Rate of Leaf Litter Decomposition in the Sub-tropical Forest Ecosystem of Manipur.
  Kh. Sunanda Devi and Th. Binoy Singh

- Abundance of Microarthropods
  Kh. Sunanda Devi and Th. Binoy Singh

- Impact of Microarthropods on Leaf Litter Decomposition at Phayeng Sub-tropical Forest, Manipur
  Kh. Sunanda Devi and Th. Binoy Singh